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1989 FIELD VALIDATION OF THE PROPOSED ICE REGIME SHIPPING CONTROL SYSTEM ONBOARD MV LUCIEN PAQUIN

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March 21, 1990

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17. Abstract This report presents the findings of a field programme to conduct a trial evaluation of the Ice Regime Shipping Control System, proposed as part of the revisions to the Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR). The shipboard work was conducted onboard MV Lucien Paquin, a general cargo vessel, during the 1989 eastern Arctic sealift. It involved operations in Foxe Basin, N.W.T. during the first half of September. The voyage was the third in a series of four trials conducted during the 1989 shipping season.

The field trial involved: generating experimental ice regime charts for broadcast to the study ship; monitoring the reception and utilization in voyage planning of all ice information products received on the vessel's bridge; and monitoring environmental and navigational particulars during the ensuing transit. Ice conditions encountered were predominantly thick, decayed first-year ice in the form of strips and patches of brash and ice cakes. In post-voyage analysis, ice conditions depicted on the charts were compared to those actually encountered, and an assessment was made of the impact of the regulatory proposal on the advisability of operations for all ice class ships. An assessment was also made of the apparent workability of the ice regime control system.

Overall, the ice regime system was found to be a logical and workable means of administering regulatory guidance, and completely compatible with the principles of safe navigation. A few specific conclusions and recommendations are put forward relating to the content and presentation of future regulatory ice regime products, and the process of calculating decision numerals under the proposed system.

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17. Résumé

Ce rapport présente les résultats d'un programme d'essais sur le terrain visant à l'évaluation du Système de contrôle du régime des glaces pour la navigation. Ce système compte parmi les modifications que l'on envisage d'apporter au Règlement sur la prévention de la pollution des eaux arctiques par les navires (CASPPR). L'exercice a eu lieu à bord du M.V. Lucien Paquin, cargo non spécialisé, pendant le transport de 1989 dans l'est de l'Arctique. Le navire a navigué dans le bassin Foxe (Territoires du Nord-Ouest) pendant la première quinzaine de septembre. Il s'agissait du troisième essai d'une série de quatre pour la saison de navigation 1989.

Dans cet essai sur le terrain, on a produit des cartes des glaces à titre expérimental en vue de leur transmission au navire d'étude, surveillé la réception et l'utilisation dans la planification du déplacement de toutes les données glacielles envoyées à la passerelle et contrôlé les conditions ambiantes et les circonstances de la navigation pendant le déplacement lui-même. Sur la majeure partie de l'itinéraire, il y avait de la glace de première année épaisse et désintégrée sous forme de cordons et de bancs de sarrasins ou de glaçons. Dans l'analyse postnavigation, on a comparé les conditions glacielles décrites par les cartes aux conditions directement observées et on a évalué l'incidence de la proposition de modification du règlement sur l'opportunité des déplacements possibles de tous les navires capables de naviguer dans les glaces, ainsi que l'exploitabilité apparente du Système de contrôle du régime des glaces.

On a jugé dans l'ensemble que ce système était un moyen logique et praticable de guider le navigateur dans le cadre du nouveau règlement, et ce, sans danger aucun pour la sécurité de la navigation. Le rapport expose quelques conclusions et recommandations bien précises sur le fond et la forme de futurs produits d'information sur le régime des glaces et le calcul de coordonnées de décision dans le système projeté.

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ABSTRACT

This report presents the findings of a field programme to conduct a trial evaluation of the Ice Regime Shipping Control System, proposed as part of the revisions to the Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR). The shipboard work was conducted onboard MV Lucien Paquin, a general cargo vessel, during the 1989 eastern Arctic sealift. It involved operations in Foxe Basin, N.W.T. during the first half of September. The voyage was the third in a series of four trials conducted during the 1989 shipping season.

The field trial involved: generating experimental ice regime charts for broadcast to the study ship; monitoring the reception and utilization in voyage planning of all ice information products received on the vessel's bridge; and monitoring environmental and navigational particulars during the ensuing transit. Ice conditions encountered were predominantly thick, decayed first-year ice in the form of strips and patches of brash and ice cakes. In post-voyage analysis, ice conditions depicted on the charts were compared to those actually encountered, and an assessment was made of the impact of the regulatory proposal on the advisability of operations for all ice class ships. An assessment was also made of the apparent workability of the ice regime control system.

Overall, the ice regime system was found to be a logical and workable means of administering regulatory guidance, and completely compatible with the principles of safe navigation. A few specific conclusions and recommendations are put forward relating to the content and presentation of future regulatory ice regime products, and the process of calculating decision numerals under the proposed system.

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We also wish to thank the staff at AES Ice Centre, Ottawa, for their assistance in the preparation and transmission of the experimental ice regime charts.

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1989 FIELD VALIDATION OF THE PROPOSED ICE REGIME SHIPPING CONTROL SYSTEM ONBOARD MV LUCIEN PAQUIN

1.0 INTRODUCTION

This report presents the findings of a field programme to conduct a trial evaluation of recently proposed revisions to the Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR). The shipboard work was conducted onboard MV Lucien Paquin during the 1989 eastern Arctic sealift. It involved operations in Foxe Basin during the first half of September.

1.1 Background

Canadian Coast Guard Northern (1989a) have recently proposed revisions to the existing CASPPR. The revisions include a new Arctic vessel classification system with associated minimum structural design requirements. They also introduce a regulatory scheme known as the Ice Regime Control System, which is intended to bring flexibility to the existing zone/date approach to controlling shipping activity in Canada's Arctic waters.

The ice regime system was developed by the Subcommittee on the Update of the CASPPR (Canadian Coast Guard Northern, 1989b). It is based upon identifiable "ice regimes", which are made up of one or more types of ice (following WMO, 1985). Each ice type is assigned a numerical "Ice Multiplier", the value of which is dependant on the ice classification of the vessel. A "Decision Numeral" is then generated by taking the sum of the products of the concentrations of ice types present (in tenths) and their assigned ice multipliers. The decision numeral is therefore unique to the particular ice regime and the ship operating within its boundaries. Ice multipliers may be adjusted in consideration of state of decay and/or degree of roughness of the ice; decision numerals may also be adjusted in consideration of suitable escort. For the final decision numeral, a value of less than zero indicates that entry is inadvisable; zero and higher values allow vessel entry. A draft of the proposed system is included in Appendix A.

The primary source of ice regime information upon which the decision numeral calculations are based will be ice analysis charts produced by the Ice Branch of the Atmospheric Environment Service (AES) and transmitted to ships via marine radio facsimile. A ship's master may, however, utilize other ice information sources (such as visual observations from shipboard or aerial reconnaissance, and/or airborne radar imagery) to identify ice regimes and calculate appropriate decision numerals. If an allowable route can be identified using these information sources, whereby all the regimes along the route have decision numerals greater than or equal to zero, the vessel may proceed through the defined regimes.

The draft regulations state that where decision numerals are calculated based on information other than that presented on the AES ice charts, a description of the projected route (including ice conditions and decision numerals) must be communicated to a Coast Guard Ice Operations Centre before transit, and particulars of the ensuing voyage must be documented and filed in the form of an after-action report.

1.2 1989 Field Validation Trials

It was recognized that before the ice regime system could be set into regulation, more practical experience with the proposal was needed. To address this need, a series of shipboard field trials were conducted during the 1989 shipping season.

In order to conduct a comprehensive evaluation, trials were conducted on a variety of ships, and in different regions of the Arctic. Following is list of those voyages:

Voyage 1: CCGS Sir John Franklin, from Barrow Strait to Dease Strait via Peel Sound, in two attempts, during July and August, 1989.

Voyage 2: CCGS Henry Larsen, from Pond Inlet to Eureka via Jones Sound, during August, 1989.

Voyage 3: MV Lucien Paquin, on a circuit of Foxe Basin, during September, 1989.

Voyage 4: MV Arctic, through Davis Strait and Baffin Bay, during November, 1989.

An earlier trial was also conducted on board MV Arctic during November, 1988 (Wells and Hagen, 1989). Each ship and its voyage is a case study of the system, to see that it works for the given ship in the given area, at the particular time of year. **Figure 1-1** presents a base map of the high Arctic, showing existing CASPPR zones along with the areas travelled during the 1989 field trials.

MV Lucien Paquin presented an opportunity to study several aspects of the proposed system for the first time in the field, including:

1. The application of the system to a traditional but as yet untried (in terms of ice regimes) shipping route.

2. The application of the system to a Type ship (MV Lucien Paquin is classed as a Type B vessel under the current ASPPR ship classification rules).

3. The application of the system to a ship operating with only conventional information available on board, ie. without the benefit of helicopter reconnaissance and/or airborne radar imagery.

4. The application of the system to a primarily first-year ice environment during the advanced melt stage of the annual ice cycle, allowing the effect of decayed ice on ice numeral calculations to be taken into account.

1.3 Objectives

The primary objective of the field work was to validate the proposed ice regime system. Specific sub-objectives were identified as follows:

1. To trial the generation of ice regime system products at AES Ice Central.

2. To examine potential capabilities and limitations for receiving, monitoring, interpreting and applying ice information of all types on board the study vessel.

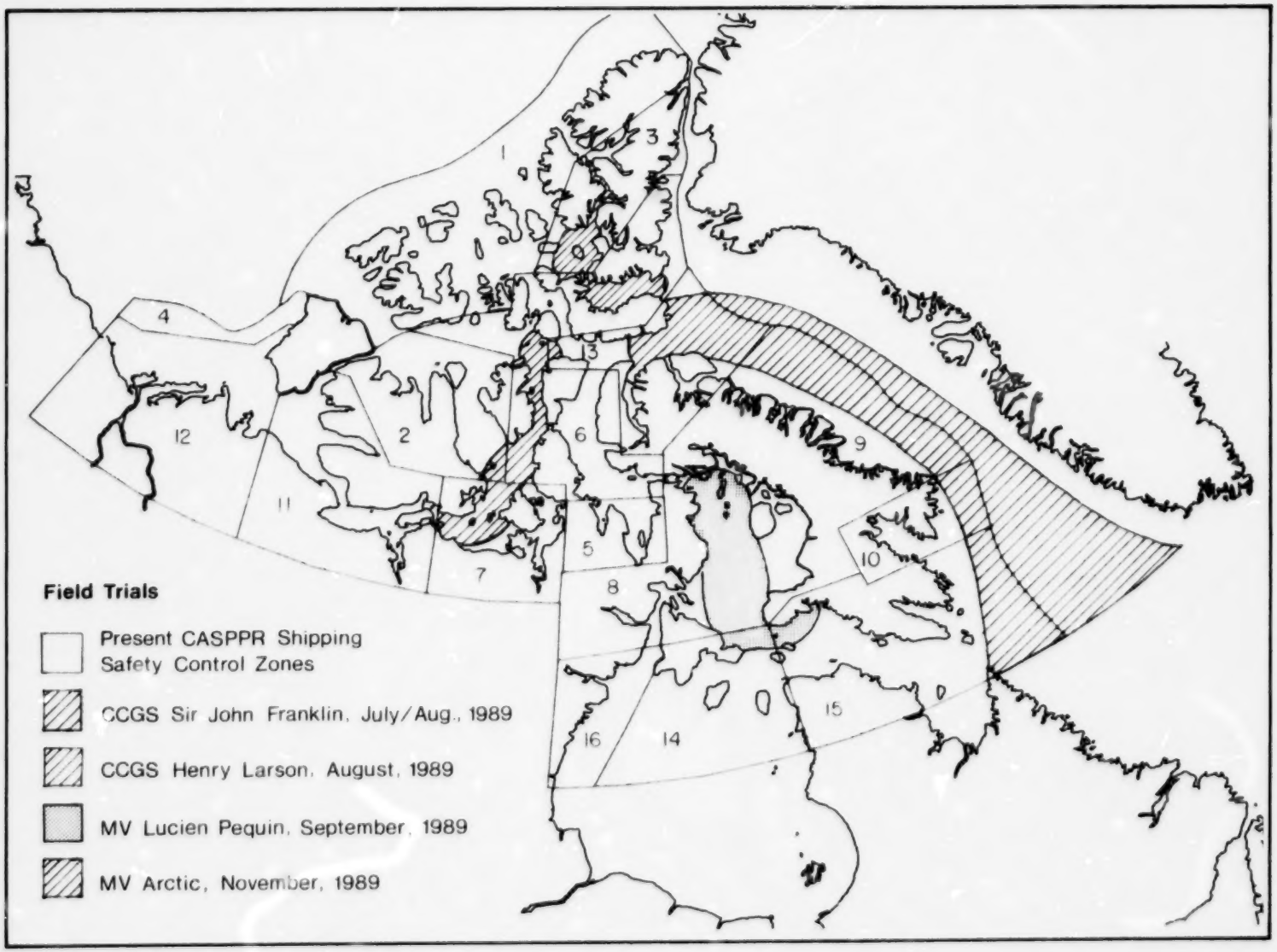


Figure 1-1 1989 Field Validation Trials of the Proposed Ice Regime Shippping Control System

3. To determine methods for ice regime identification from the shipboard perspective, and for the reporting of updated ice regime information to Coast Guard Ice Operations Centres, NORDREG and other authorities as appropriate.

4. To compare ice regimes depicted on AES ice analysis charts to ice regimes encountered during the voyage, and to determine how frequently conflicts arise which might imp on operations under the proposed regulations. Furthermore, to examine the particula circumstances at these times by comparing ice conditions encountered and the suggested advisability of operations with trafficability data collected during the transit.

1.4 Approach

For the purposes of this exercise, the Paquin was assumed to meet all applicable standards for a Type B vessel, as provided for in the revised ship classification rules presented in Appendix A. The approach to the work involved the efforts of a two man team. One researcher accompanied the ship for the field test, while another provided regulatory support which included preparing and arranging for the transmission of the ice regime chart product from AES Ice Centre. Following are the particulars of the data collection/transmission routines:

Shipboard Data Collection

The shipboard researcher was an experienced ice observer who throughout the voyage, maintained as well as possible a 24 hour watch from the bridge. Environmental conditions and vessel trafficability data were documented continuously. Data were entered onto a portable personal computer using the IDIADS format, developed over several years of trafficability data collection on board MV Arctic and other vessels. Ice and weather observations are based upon AES and WMO standards (MANICE, 1989). WMO symbology and the IDIADS data entry codes are included as **Appendix B.**

A log was kept to document the reception and utilization of all ice information products received on board the vessel. Navigational particulars and ship trafficability were at all times related to these products.

Experimental Ice Regime Charts

In parallel with the program of shipboard investigation, a Norland project scientist knowledgeable in the ice regime system prepared experimental ice regime charts at the AES Ice Centre for routine transmission to the study ship. The charts were produced at the same scale as the daily analysis chart, and showed the same ice regime boundaries. The egg codes were replaced by a Minimum Entry Criteria (MEC) for a base ship, as calculated from the ice regime system (ie. the lowest category of ship permitted to navigate within the ice regime boundaries).

A computer program which calculates decision numerals based on egg code information was made available for use on a portable computer at AES, and on board the study vessel. During operational periods, the ice regime charts were prepared between 1400 and 1600 hrs local time.

The ship owner and charter-party were briefed on the ice regime system and the project objectives prior to embarking on the voyage. During the trial, an ongoing dialogue on the ice regime system was maintained with the ship's Captain and his officers, however ice information products and calculations specificlly related to the ice regime system were not used operationally.

1.5 Report Organization

This report is divided into five sections, the first of which is this introduction. Section two presents the results of the field trial. The implications of these results in terms of the ice regime system as a whole are the subject of discussion in section three. Conclusions and recommendations comprise the fourth section, and references are listed in the fifth. Four appendices complete the document.

2.0 RESULTS

This section presents the results of data collection and analysis activities. It begins with a brief overview of the ice regime of Foxe Basin. The overview provides a perspective on regional historical climatology, as well as a review of ice breakup in 1989, prior to arrival in the area of MV Lucien Paquin. The second component of the section is a synopsis of the ensuing voyage. A chronology of major events in the commercial voyage is supported by a general discussion covering ice conditions encountered and their impact on navigation.

Ice regimes based on both AES ice analysis charts and observed ice conditions are then presented in summary form for the entire voyage. The accompanying discussion is limited to factors contributing directly to the generation of these results. The implications of the results, in terms of system implementation and the advisability of operations for all ship classes, are discussed in Section 3.0.

2.1 The Foxe Basin Ice Regime

2.1.1 Regional Climatology

The climate of Foxe Basin is relatively mild in comparison to much of the Canadian Arctic Archipelago. Similar to Amundsen Gulf to the west, and Northern Baffin Bay, Melting Degree Day (MDD) accumulation normally begins by mid June, with an average seasonal accumulation in the neighbourhood of 500 MDD. Freezing Degree Day (FDD) accumulation normally begins by the last week of September, with an average seasonal accumulation of around 5000 FDD.

Although the basin has been known to consolidate over winter, this is rare and it is usually covered in close pack first-year ice, with a maximum thickness of 175 to 200 cm. The incidence of old ice in Foxe Basin is very low. Small quantities of old ice occasionally drift eastward through Fury and Hecla Strait into the northern reaches of the basin, however the probability of occurrence is generally less than 25% (Markham, 1981). Some old ice, usually second-year, may be present in years following incomplete breakup and melt of the ice cover.

Two recurring polynyas, one north of Bray Island and the other north-west of Hall Beach and Igloolik, east of the consolidated ice of Fury and Hecla Strait, are exceptions to the close pack ice typical of late winter conditions. The latter polynya has been related to prevailing north-westerly winds and southward flowing currents. Adjacent to this feature is a large area of open pack ice (approximately 600 sq.n.mi.) which persists through the winter and extends southward along the shorefast ice, usually as far as Hall Beach (Smith and Rigby, 1981).

As temperatures warm in May and June, the Fury and Hecla Strait polynya enlarges to the southeast. At the same time the winter pack ice begins to clear from Hudson Strait, and by early July this breakup has usually advanced through Foxe Channel into Foxe Basin from the south-east, to meet the enlarging polynya.

Open to close pack conditions generally prevail through most of Foxe Basin by the first week of August. By the end of August, open water and very open pack dominate, except for close pack ice which often persists north-west of Foxe Channel. By the third week of September, Foxe Basin is normally open water.

New ice typically begins forming in the northern sections of Foxe Basin during the second week of October, rapidly extending southward to cover the water body by the end of the month.

2.1.2 Ice Breakup in 1989

Ice conditions and breakup in Foxe Basin preceeding the voyage of MV Lucien Paquin are based on weekly composite ice charts and 30 day ice forecasts for northern Canadian waters, issued by Ice Forecasting Central, Environment Canada.

Near normal temperatures characterized the early summer period. By the middle of August close to very close pack first year ice covered the southern portions of Foxe Basin, with mainly open water and very open pack in the northern section. Clearing of the pack was estimated at the time to be about one week behind normal. With the expectation of continued normal temperatures (around 3-5 C), and spillage of pack ice into Hudson Bay, Foxe Basin was forecast to be mostly open water by mid-September.

Figure 2-1 shows the August 31, 1989 composite ice conditions chart for Eastern Arctic waters. Seven tenths of medium and thick first-year ice covers much of the southern basin, while to the north lower total concentrations with strips and patches of nine tenths first-year prevail. By September 5, the day before the field trial began, conditions were near normal in the northern portion of Foxe Basin, while to the south conditions ranged from open drift to close pack thick first-year ice, with clearing estimated to be about 10 days behind normal.

2.2 Voyage Synopsis

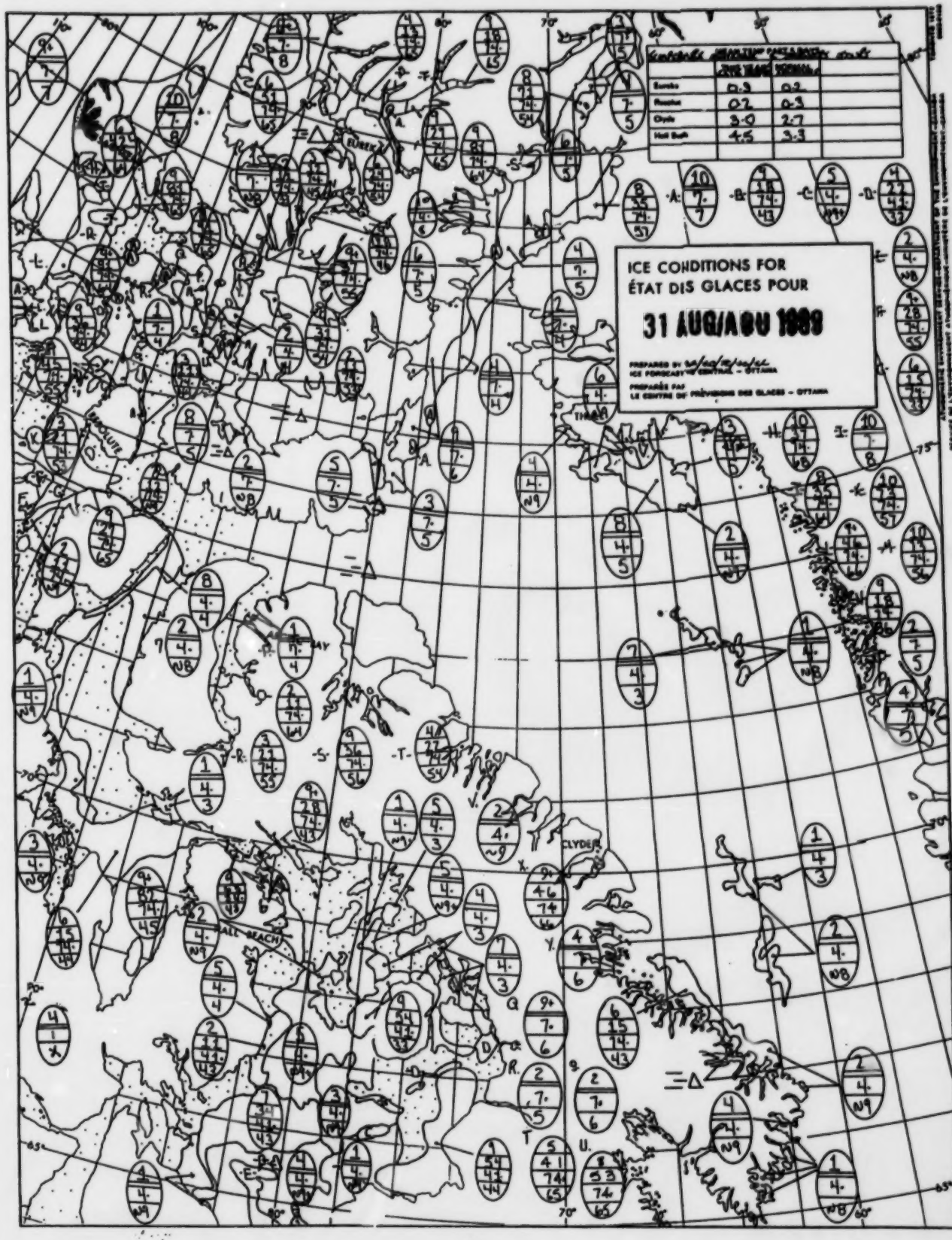
The voyage of MV Lucien Paquin was representative of traditional mid-season Eastern Arctic sealift operations. The ship sailed from Montreal on August 10, 1989 carrying general cargo bound for seven Arctic ports; Breevort, Repulse Bay, Hall Beach, Igloolik, Rowley Island, Bray Island and finally, Cape Dorset. The latter portion of the voyage was chosen for the CASPPR trial because it involved a circuit of Foxe Basin, where the persistence of first-year sea ice could be expected to influence vessel navigation.

The field trial began at the native hamlet of Igloolik on September 6, and ended at Cape Dorset on September 15. En route, calls were made at military installations on Rowley Island and Bray Island. In all cases, cargo was moved ashore using two tug and barge outfits. A site map showing these ports and the general route followed by the ship is included as Figure 2-2. Table 2.1 presents a brief chronology of major events during the exercise.

Most of the voyage was made through open water, however strips and patches of first-year ice which impacted on routing decisions were encountered at least once on every leg of the voyage. Departure from Igloolik was delayed by about eight hours when information was received indicating close pack first-year ice outside the harbour. The ice regime was negotiated in daylight, enabling the master to identify visually and avoid areas of highest concentration.

Strips and patches of first-year ice, varying in concentration from open to very close pack, also impacted on operations at Bray Island. The initial approach to the anchorage was hampered by ice and the onset of darkness, and about two hours were spent manoeuvring around and through the ice. Ice continued to drift through the area throughout cargo operations, occasionally blocking the tugs and twice forcing the vessel to raise anchor and move clear of very close pack ice.

The majority of ice was encountered in the southern portion of the Basin. On the southbound leg, between Bray Island and Cape Dorset, the ship was forced to turn back when an ice edge, encroaching from the west, would have forced the ship eastward into a region of poor bathymetry. Once again darkness was a contributing factor, and instead of attempting to negotiate the strip the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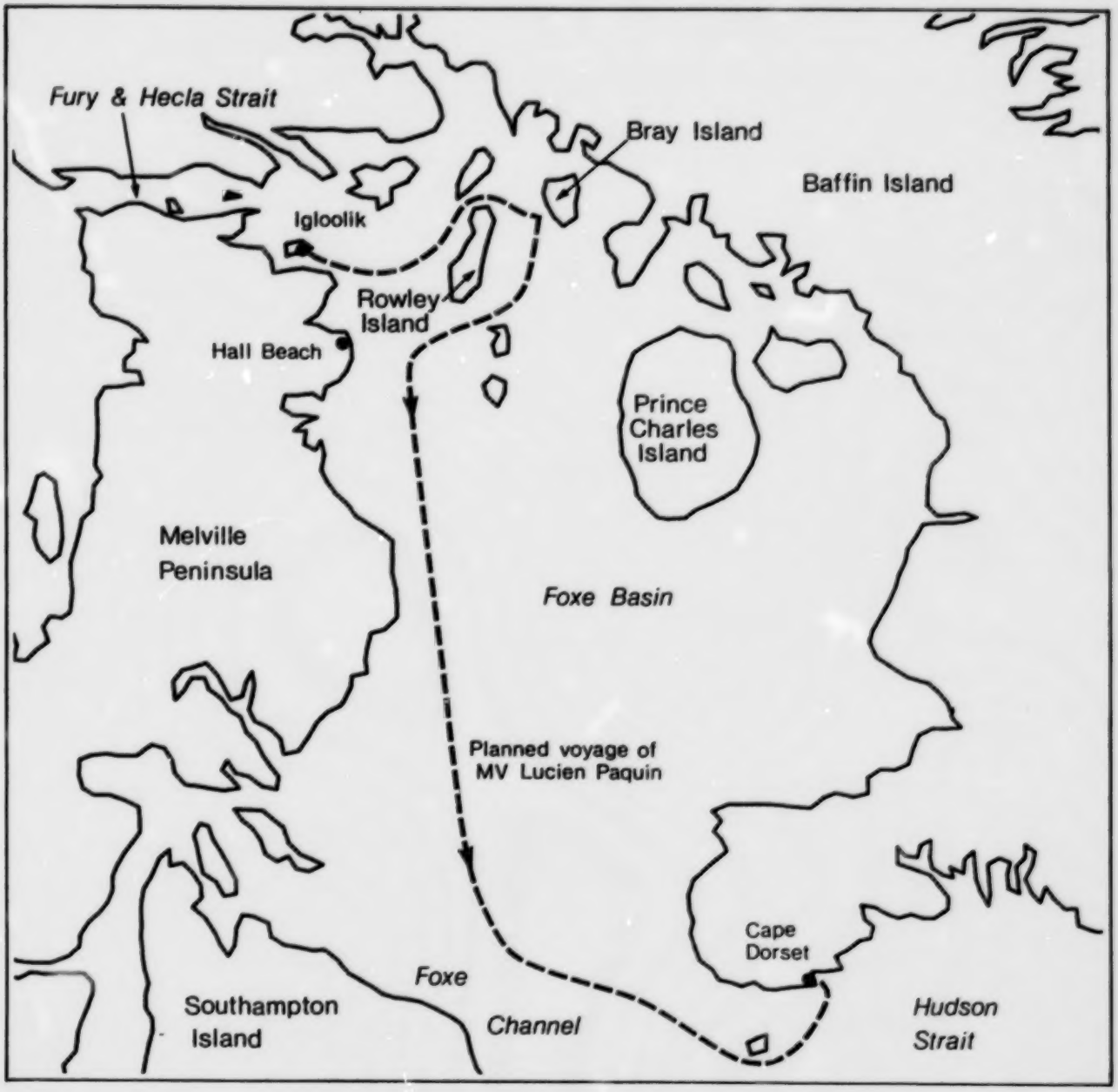

Figure 2-2 Foxe Basin Site Map

Table 2.1
Chronology of Events

Date (1989)	Description
Sept 2	Ice observer joins MV Lucien Paquin.
Sept 3-5	Cargo discharged at Igloolik, N.W.T. Ship anchored in a trace first-year ice, drifting floes hamper barge operations.
Sept 5	Cargo operations complete by early evening. CCGS Norman McLeod Rogers in area reports strip of 9/10 first-year ice across entrance to harbour. Departure delayed so as not to encounter ice before first light.
Sept 6	0800 (GMT; 0400 hrs local time), depart Igloolik. 0900-1000 negotiate strips and patches of open to close pack first-year ice before reaching open water. 1400, arrive at Rowley Island, N.W.T. Anchor in open water.
Sept 7-8	Cargo discharged at Rowley Island.
Sept 8	2100, depart Rowley Island, ice free waters.
Sept 9	0000-0200, very close pack first year ice encountered blocking access to Bray Island. Highest concentration of ice avoided, some close pack ice negotiated. 0300, arrive at Bray island, N.W.T. Anchor in open water.
Sept 9-12	Cargo discharged at Bray Island. First-year ice strip along coastline hampers barge operations.
Sept 10	0200, north-west winds have carried strips and patches of first-year to ship; engines started and vessel moved westward out of southward drifting ice. 2300, again amidst drifting ice, move further west through very close pack first-year ice into open water.
Sept 13	0100, depart Bray Island in open water. 0500, reverse course after being squeezed between ice edge to west and limiting bathymetry to east. Follow ice edge in darkness, heading north. 0730, traverse narrow strip of open pack first-year ice into open water, resume southward voyage. 1600, encounter strips and patches of first-year ice, variable concentrations. Negotiate ice at slow speed.
Sept 14	0100, ship stopped for night amidst open pack ice in consideration of poor visibility caused by darkness and blowing snow. 0900, resume passage. 1100, reach open water. 2100, arrive Cape Dorset, N.W.T., observer departs ship.
Sept 15	Ice observer departs Cape Dorset.

master elected to follow the ice edge northward until a clear route could be seen through to open water on the other side. The ship sailed north for two hours before finding such an opening.

Open water prevailed through the following morning, however extensive reaches of strips and patches of first-year ice were encountered by mid afternoon. As daylight waned, the ship proceeded through the ice at reduced speed, steering clear of heavier concentrations and avoiding contact with the small floes and cakes wherever possible. The ship was stopped for the night at 9:00 pm local time as visibility was further reduced by blowing snow. Passage was resumed at first light, and within hours the ship was clear into open water. No further ice was seen for the remainder of the voyage.

2.3 Field Data

Ice analysis charts and experimental ice regime charts, generated at the AES Ice Centre in Ottawa and transmitted via Iqaluit Coast Guard Radio, were received daily onboard MV Lucien Paquin during operational periods. The original charts, at 1:2 million scale, were produced and transmitted on 17" x 22" paper. The ships marine facsimile receiver (dry paper type) produced a scaled down product 9-1/2" x 12". Chart quality was consistently good, although the reduced scale and blurred print sometimes combined to limit readability. Reduced size copies of the original charts are included in **Appendix C.**

Vessel trafficability records comprised of ice information reception and utilization, encountered ice and weather conditions, and navigational particulars were kept continuously during transit. 35mm slides were also logged. Unfortunately, difficulties were experienced in processing the film and the slides produced were unsatisfactory. All observations were stored using the IDIADS database software described earlier in Section 1.4. Data were subject to quality assurance checks, and formatted as appropriate for the database management system and supplementary analysis software. Listings of data are included in **Appendix D.**

2.4 Ice Regime Analysis

In some marine operations ice information of a local, tactical nature, such as helicopter reconnaissance flights or airborne radar imagery, may be available to support navigation. Such was the case in the trial of CCGS Sir John Franklin, when these additional information sources were incorporated to produce a "modified" ice regime chart, for the purposes of calculating decision numerals along the planned route (Cameron et. al., 1989). Planning was much simpler in the case of MV Lucien Paquin. Only the minimum ice information was available to support the voyage. This information consisted of AES ice charts, marine radar and visual observations, supplemented by daily NORDREG radio reports.

Voyage legs covered relatively short distances through mainly open water, with seldom more than one or two ice regimes along the way. MEC for these regimes were included on the experimental CASPPR ice regime charts, and observed ice conditions were generally consistent with those expected. For these reasons, no occasion ever arose during the trial where it might have been necessary to prepare and transmit to the home office a report of ice regime descriptions and associated decision numerals.

Two types of ice regimes are presented in this analysis; those expected, and those actually encountered. Expected ice regimes are those which were depicted on the most current AES ice analysis chart along the route followed by the ship. Actual ice regimes were those recorded hourly, based on shipboard observations of ice conditions encountered over the preceeding hour. For both cases, decision numerals for MV Lucien Paquin as well as MEC for a base ship case have been generated.

The following factors were considered in determining ice type multipliers and decision numerals:

i) MV Lucien Paquin was assumed to meet all applicable standards for a Type B vessel, as provided for in the revised ship classification rules presented in Appendix A.

ii) The first-year ice was found to be predominantly brash and ice cake, with small floes common. Because of the advanced decay of the unconsolidated rubble, ice thickness was highly variable. However, since much of the rubble and almost all of the larger floes were greater than 120 cm in thickness, the ice was classed as "thick first-year" throughout. The AES charts also specified thick first-year ice.

iii) All ice was considered to be in an advanced state of decay, therefore ice type multipliers were increased by a value of "+1".

iv) MV Lucien Paquin was not provided a "suitable escort", and therefore the ice numeral was the same as the decision numeral.

Results are tabulated in Appendix D along with listings of hourly trafficability data. Observed ice regimes were taken directly from the hourly ice data records. Expected ice regimes were taken from egg codes shown on the most current AES analysis chart, corresponding to the ship's position at that time.

The results are presented graphically in **Figures 2-3** to **2-5**. The figures show the three experimental ice regime charts which were the most current versions of the series at the time each of the three voyage legs was undertaken. Also plotted on the figures is the applicable route followed by the ship. The route is broken into segments, where each segment represents a change in the decision numeral for MV Lucien Paquin, as calculated from observed ice conditions. The decision numeral is included alongside the corresponding segment. The data and time is also given at each segment end point, for reference to the trafficability data listings.

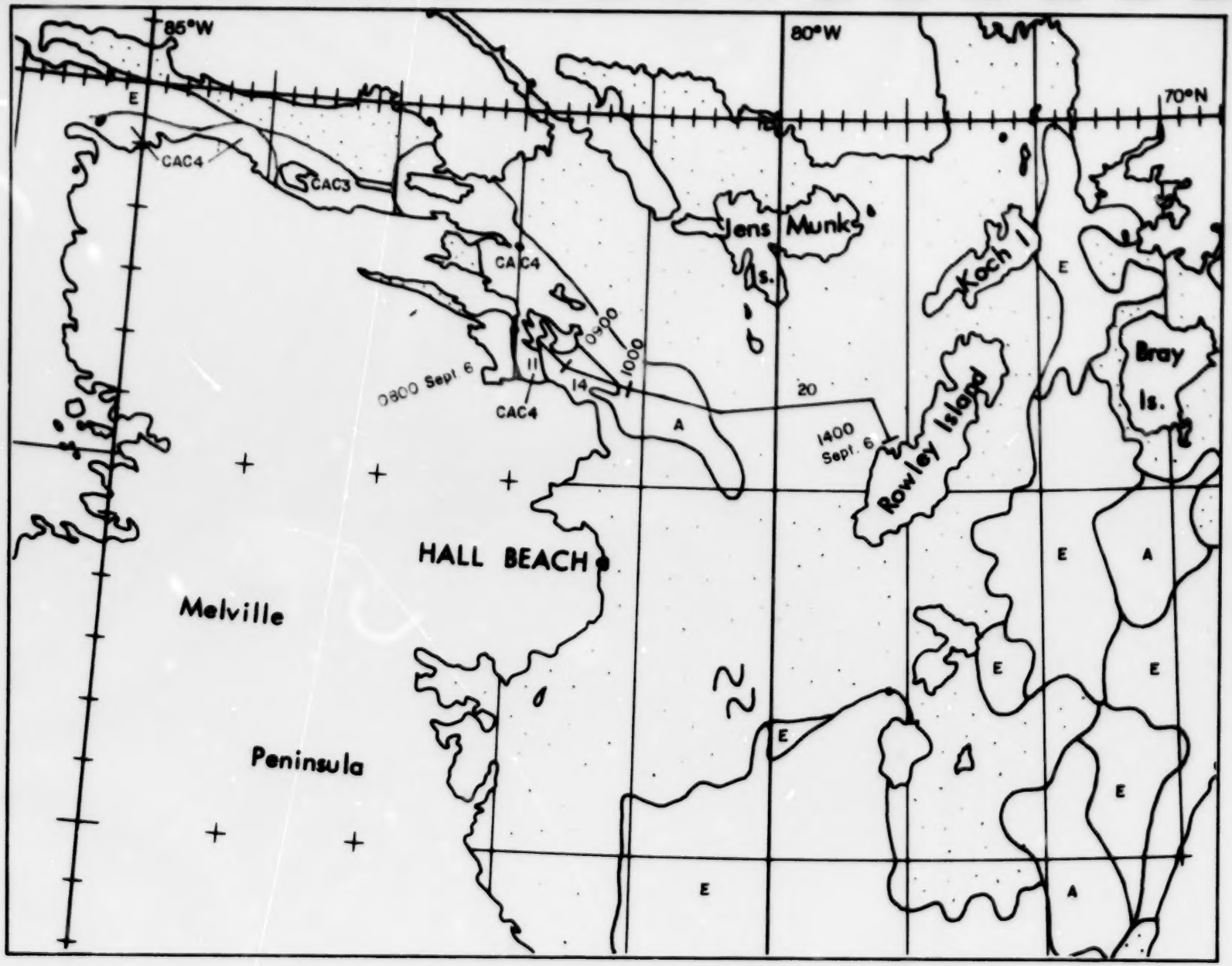

Figure 2-3 Observed Ship Track with Ice Regime Decision Numerals
Igloolik to Rowley Island, N.W.T., September 6, 1989

Base Map from CASPPR Experimental Ice Regime Chart, September 6, 1989

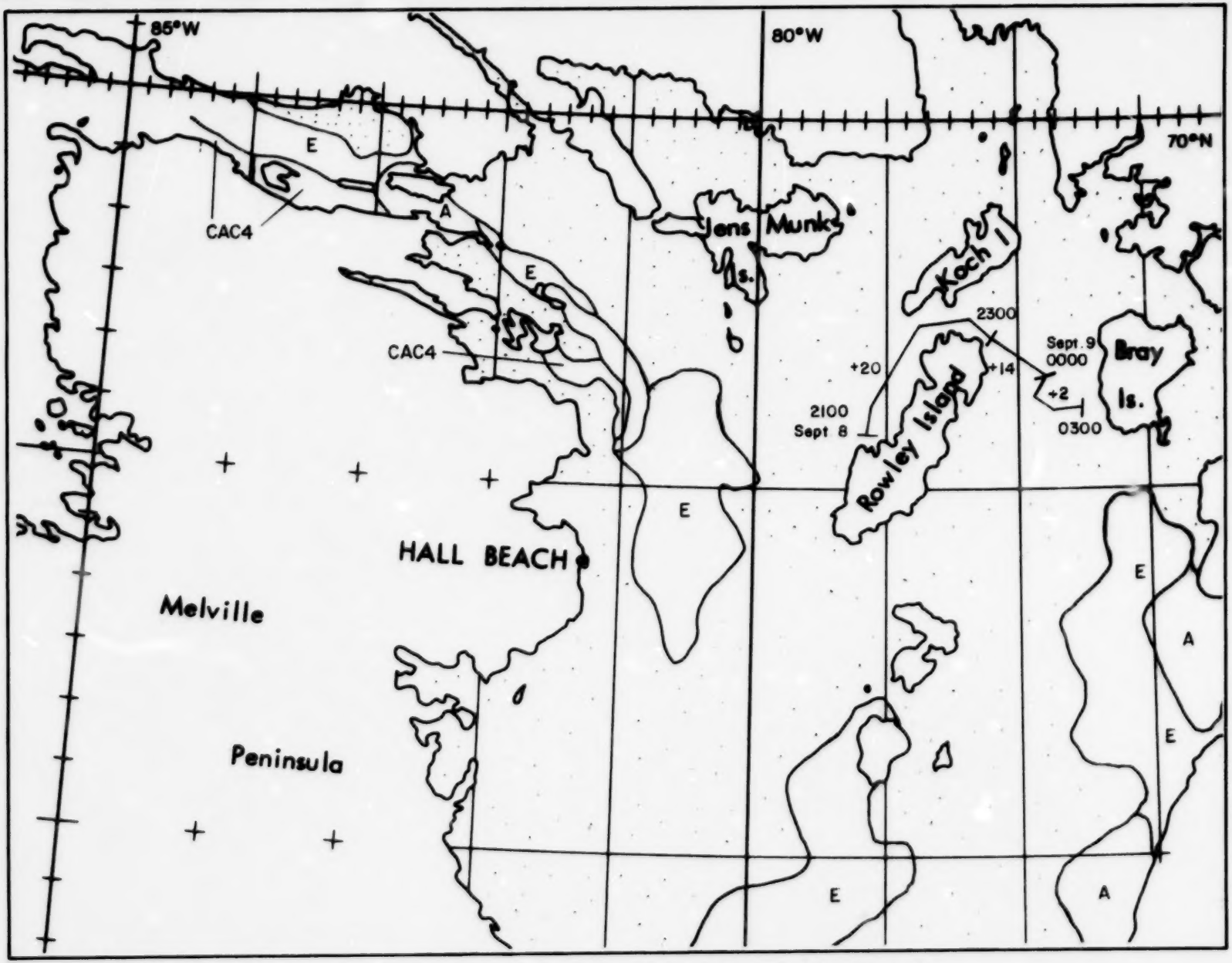

Figure 2-4 Observed Ship Track with Ice Regime Decision Numerals
Rowley Island to Bray Island, N.W.T., September 8-9, 1989

Base Map from CASPPR Experimental Ice Regime Chart, September 8, 1989

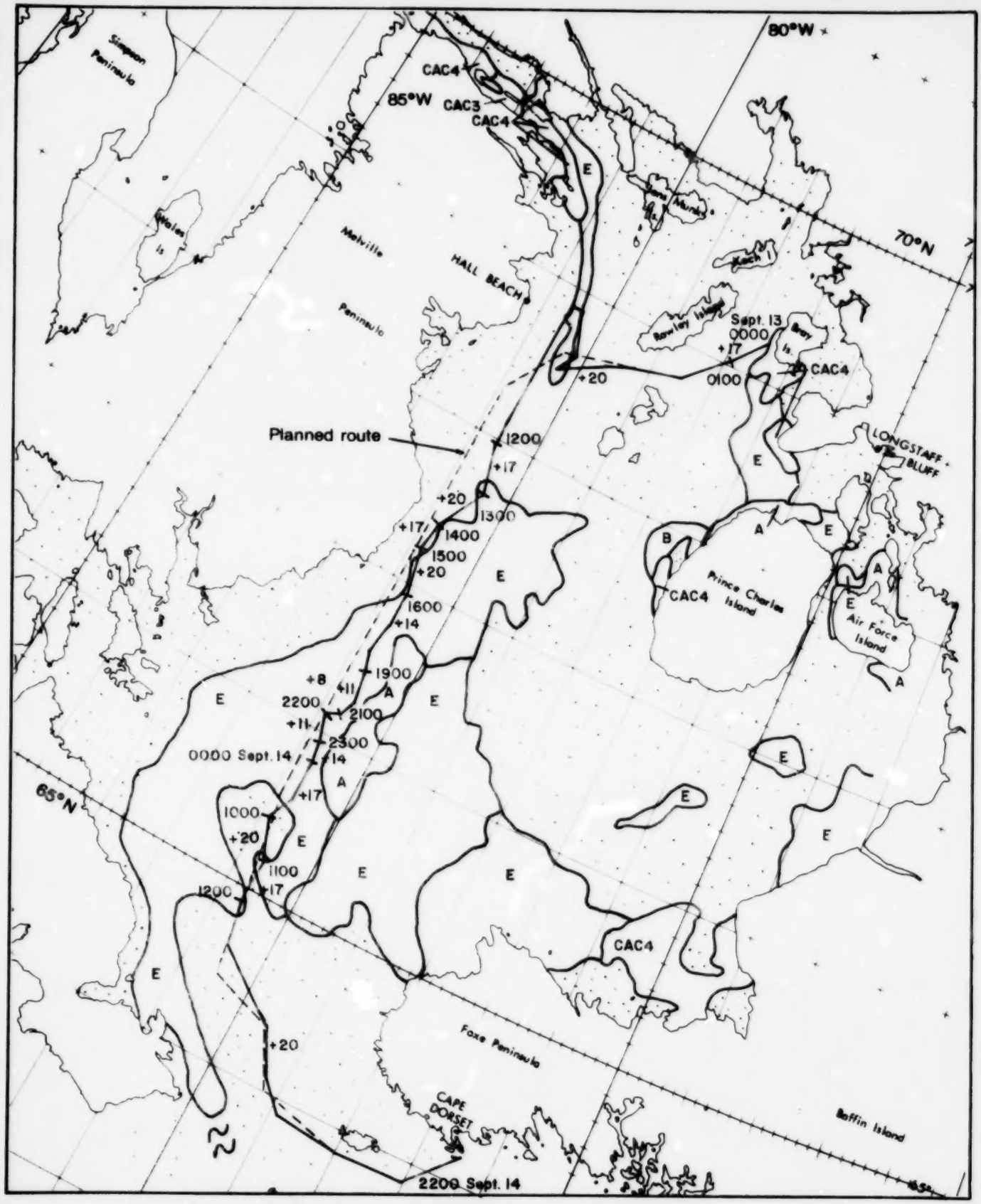

Figure 2-5 Observed Ship Track with Ice Regime Decision Numerals
Bray Island to Cape Dorset, N.W.T., September 13-14, 1989

Base Map from CASPPR Experimental Ice Regime Chart, September 13, 1989

3.0 DISCUSSION

This section contains a discussion of the results presented in Section 2.0. Many of the results are naturally specific to the study ship, however an attempt is made to look at their implications in terms of the ice regime system as a whole, in order that the trial may be as comprehensive as possible.

The first topic covered is the generation and application of experimental ice regime charts. A comparison is then made between ice regimes depicted on ice charts, and those observed in the immediate vicinity of the vessel during transit.

The discussion then considers the decision numeral calculation process. This is followed by a review of allowable operations, wherein decision numerals are presented for ships of all ice classes. The section closes with a few general remarks, apparent from the field trial, regarding operational implementation of the ice regime system.

3.1 Experimental Ice Regime Charts

Ice analysis charts produced at the AES Ice Centre, are currently the main source of strategic ice information available to mariners. The charts are updated daily and broadcast routinely, via Coast Guard radio, across the Canadian Arctic. Current rules require that all ships operating within CASPPR control zones carry operational facsimile receivers. With the existing infrastructure, ice charts are seen as a logical mechanism to provide regulatory guidance under the proposed ice regime system.

Initial field trials conducted onboard MV Arctic (Wells and Hagen, 1989) found that the synoptic analysis charts were well suited to the ice regime system, and it was recommended that the existing charts be adapted to include regulatory information. This would involve the addition of a single alphabetic character to each ice regime egg code, designating the MEC for a base ship.

For the 1989 trials the MEC was calculated daily for each ice regime, but was not included on the ice analysis charts because of that products operational application and wide distribution. Instead a separate chart, incorporating identical ice regimes and area/scale of presentation, but clearly designated as experimental for use by the study ship only, was transmitted immediately following the scheduled broadcast. These charts included only the MEC designator for each ice regime.

The Paquin field trial highlighted the need for certain supplementary information to appear on the chart, in addition to the MEC. The required information relates to the two ice property variables not usually specified in the egg code, but which may be taken into account in decision numeral calculations. The two variables are ice decay and surface roughness (degree of ridging and/or rubble). Sufficient information to establish criteria for both of these variables are not always available to the forecaster when he prepares the analysis charts, and their presence therefore may or may not be incorporated into the MEC calculation provided on the regulatory chart.

It was well known by ice forecasters that first-year ice in Foxe Basin in September could be expected to be decayed, and during this trial that assumption was made in determining the MEC. In order to clarify this point, the Norland project scientist preparing the ice regime chart added a special note to that effect in the legend box. However, as the transition from strong to decayed ice is gradual early in the season, and may be variable across the regions covered by the chart, it will not always be possible to make such an assumption.

Surface roughness is currently reported only on observed charts generated by AES Ice Reconnaissance, and is not incorporated into the daily analysis charts. However, it is expected that the introduction at the AES Ice Centre of both the Expanded Ice Services Program (EISP) and the

Comprehensive Ice Reconnaissance Service (CIRS) will improve the quantity and quality of ice information on which the analysis charts are based. It may be possible in future to include appropriate symbology for ridging along with the egg code descriptors.

In practice, it will be necessary for some mechanism to be in place by which a mariner is able to establish all of the assumptions which have been made in generating the MEC associated with individual ice regimes. Without this information, he would be unable to ascertain whether or not the assumptions made accurately reflect actual conditions, thereby calling into question the MEC.

3.2 Comparison of Ice Charts and Observed Ice Conditions

The comparison of ice conditions depicted on analysis charts to those observed in the field is both a comparison of the location, extent and type of ice, as well as a comparison of synoptic analysis results to "tactical, close range" observations. These points of view are quite different, with the result that some discrepancies in ice regime calls are not unexpected. The subject is discussed in MANICE, and a number of case studies are documented in the trafficability literature. The problem arises from the fact that shipboard observations have a relatively narrow field of view, and the viewing angle is low enough that the freeboard of the ice, particularly when ridging and rubble is present, often obscures at least partially the ice conditions further away. The other inherent difference is that to the extent possible ships generally practice ice avoidance, thereby creating a bias in the shipboard field of view.

With this in mind, shipboard observations show that the ice analysis charts were fairly accurate during the field trial, with one important exception. The exception was the presence of first-year pack ice north and west of Bray Island during the period September 9th-12th. This ice was shown on every chart between September 3rd and 7th, confirmed by aerial reconnaissance of the region undertaken on September 6th. However, the charts of September 8th and 9th indicated a rapid southward clearing of this ice under the influence of north to north-westerly winds. The chart of the 9th indicated open water north and west of Bray Island, whereas the ship encountered strips and patches of open to very close pack first-year ice on that date, and over the following three days while lying at anchor approximately 5km off the west coast of the island. The ice analysis chart of September 10th depicted continuing southward drift of this ice, however a reconnaissance flight of the same day appeared to have discovered the inaccuracy, as it was rectified on the next days chart.

This exception aside, the vast majority of areas depicted as open water were free of all but occasional traces of drifting pack ice. However, it is difficult to say exactly how accurate the ice charts were because most ice regimes through the central and southern portions of the Basin were characterized by some overall concentration consisting of open water, with strips and patches of closely packed ice. This is a natural phenomenon common when small floes, cakes and brash ice are free to drift under the influence of winds and currents.

When the ship traversed these fairly large areas (usually between 10 and 50 n.mi. across), the strips and patches would be encountered to a greater or lesser degree. This was attributed partially to chance, and partially to the fact that navigators would tend to steer clear of those ice edges which appeared most dense. Often two or more hourly shipboard observations would be made within a given ice regime shown on the analysis chart. Therefore, any given record of ice conditions would not necessarily coincide with the average concentration over the broader region. In general, the data show that observed ice conditions were consistent with those which would be expected because of the "strips and patches" characteristic of the regimes.

A small amount of dark nilas was observed in the southern Basin. Otherwise, all ice encountered was decayed, thick first-year ice, as indicated on the analysis charts. The one obvious discrepancy between the shipboard and ice chart calls was floe size. The first-year ice was usually

observed in the form of cakes (floes up to 20m across), small cakes (relatively flat, less than 2m across) and/or brash, with some small floes (20-100m across). The smallest floe size given on any ice chart, however, was small floe. Although this is an obvious difference it is not significant from the point of view of the ice regime system, as floe size is not considered in the decision numeral calculation.

3.3 Decision Numeral Calculations

All assumptions used in calculating decision numerals from both ice analysis charts and shipboard observations have been described in Section 2.4. The requirement for these assumptions was entirely clear from the proposed regulations, and with one minor exception no ambiguities were perceived in the process of performing the calculations.

The exception relates reducing the ice multiplier by 1 in the case where the total ice concentration in a regime is six tenths or greater, and 30% of the area of an ice type is deformed by ridges, rubble or hummocking. There were only two occasions during the field trial when the total concentration observed from the ship reached six tenths, and in both cases the ice was deformed extensively. However, this deformation was attributed to the high concentration of brash ice, which exhibited minimal consolidation. As such, it was not considered to truly reflect an increase in ice strength and for this reason the ice multiplier was not adjusted downward. Had it been adjusted, the result would have been a negative decision numeral. Based on the ease and apparent safety of the ensuing transit, which exploited to the fullest possible extent the remaining four tenths of open water, this would not have been a reasonable restriction on the operations of MV Lucien Paquin.

3.4 Allowable Ship Operations

The case of MV Lucien Paquin was representative of typical commercial operations in an area which has traditionally seen a relatively high level of shipping activity. For this reason, the impact of the ice regime system on allowable operations for all ship classifications is of special interest.

Throughout the study period, AES ice analysis charts for Foxe Basin consistently showed a predominance of ice regimes of Type E MEC. Type A regimes were also common, and often very extensive, however there was almost always some route which a Type E vessel could exploit to move past the Type A regime, up or down the Basin.

This field trial has shown that when ice regimes are characterized by strips and patches of mobile pack ice, the synoptic scale analysis is not always representative of ice conditions encountered in the immediate vicinity of the vessel. In these cases open water is used extensively for the purposes of manoeuvring around strips of closely packed ice, which themselves would have generated negative decision numerals. On one occasion (September 6, 1100-1200 hrs.) the ship transitted an ice regime for which the MEC was given as Type A on the experimental ice regime chart, without encountering any ice more severe than that which generated a decision numeral of +11.

There were also a number of occasions when strips of ice which would have generated negative decision numerals were encountered within regimes of Type E MEC. In these cases, considerable efforts were made to avoid the densely packed strips (ie. greater than eight tenths total concentration). Evasive actions, summarized from the database reference log, are described in the voyage synopsis presented in Section 2. The result was that no negative decision numerals were recorded during the voyage.

These findings suggest that for the scenario studied, the ice regime system is well suited to practical application. Extensive open water and long hours of daylight during late summer assist the

mariner in avoiding direct contact with ice regimes which would result in negative decision numerals. For this reason, the exact locations of ice regime boundaries on the analysis charts are also less critical, and some inaccuracy is tolerable.

A concern occasionally voiced by mariners, and one which was repeated by the master of MV Lucien Paquin, relates to the possibility of becoming surrounded by ice regimes through which the ship is not allowed to travel, with the result that the ship becomes stranded at a particular location. Although such an occurrence has not been documented to date during transits studied in this field trial series, it did occur on this voyage while the ship lay at anchor off Bray Island. On September 10, on two separate occasions, drifting pack ice surrounded the vessel during cargo operations and the master was forced to move the vessel a few hundred metres through very close pack ice to reach open water. On both occasions, with 9/10 decayed first-year ice, the decision numeral for the strip of ice was -7 for MV Lucien Paquin (Type A MEC). The ship was moved at dead slow speed, and pushed its way through the ice with no apparent damage. It was probably fortunate that the ice was decayed and very weak, and made up mostly of brash and small cakes.

Table 3.1 presents a sequential listing of observed ice regimes along the transitted route, with corresponding decision numerals for each vessel classification under the proposed CASPPR rules. Route segments have been delineated based on observed ice regimes, as depicted in Figures 2-3 to 2-5, and distances have been summed from hourly distance made good data.

The table shows that for the voyage as a whole, entry was permitted for any ship of Type B or higher ice class. Type E ships would have been permitted to make the same voyage but for a 12 n.mi. stretch of six tenths first-year ice, for which decision numerals of -4 were calculated for Type E, D and C ships.

Along the way, instances were found where observed ice regimes were both more severe and less severe than indicated on the AES ice charts. This is attributed to the strips and patches characteristic of most of the AES ice regimes, and is therefore to be expected.

3.5 Considerations in Operational Implementation

There was only one instance where the ship traversed an ice regime shown on the ice chart to have a MEC exceeding Type B, however this was only determined after the fact. The ice regime description was not legible on either the ice analysis chart or the experimental ice regime chart, in spite of the fact that both charts, like all charts received during the exercise, were considered to be of "fair" to "good" quality. The ice regime in question was a narrow strip off Igloolik, and the markings on the chart were relatively small. The problem was compounded by the fact that the facsimile receiver employed on the Paquin produced a reduced scale version of the chart, and with some blurring of the print the data could not be deciphered. Although it was not a serious problem overall, it should be considered during chart preparation.

For this operation, any ice regime reports to a regulatory body which might have been required would likely have been filed once before sailing, with little or no impact on bridge manning requirements. This is because the officer on watch was not directly involved in the cargo operations, and would have had sufficient time to review ice charts and prepare any such messages before sailing. With the voyage legs so short, there was seldom any opportunity for any updated ice regime charts to be received prior to reaching the destination.

Table 3.1

Ice Regime Decision Numerals from Shipboard Observations

Route Segment	Transit Distance	Ice Regime Description Partial Concentrations (Tenths):									Ice Numeral Adjustments:			Decision Numerals for All Ship Categories:						
Number	Nautical Miles	OW	G	GW	THN FY1	THN FY2	MED	THK FY	SY	MY	Escort	Decayed Ice	>30% Rubble	E	D	C	B	A	CAC4	CAC3
1	1	9						1			N	Y	N	16	16	16	17	18	20	20
2	9	7						3			N	Y	N	8	8	8	11	14	20	23
3	6	8						2			N	Y	N	12	12	12	14	16	20	22
4	67	10									N	n/a	n/a	20	20	20	20	20	20	20
5	10	8						2			N	Y	N	12	12	12	14	16	20	22
6	6	4						6			N	Y	N	-4	-4	-4	2	8	20	26
7	4	9						1			N	Y	N	16	16	16	17	18	20	20
8	96	10									N	n/a	n/a	20	20	20	20	20	20	20
9	19	9						1			N	Y	N	16	16	16	17	18	20	20
10	18	10									N	n/a	n/a	20	20	20	20	20	20	20
11	12	9						1			N	Y	N	16	16	16	17	18	20	20
12	16	10									N	n/a	n/a	20	20	20	20	20	20	20
13	30	8						2			N	Y	N	12	12	12	14	16	20	22
14	18	7						3			N	Y	N	8	8	8	11	14	20	23
15	6	6						4			N	Y	N	4	4	4	8	12	20	24
16	10	7						3			N	Y	N	8	8	8	11	14	20	23
17	8	8						2			N	Y	N	12	12	12	14	16	20	22
18	20	9						1			N	Y	N	16	16	16	17	18	20	20
19	16	10									N	n/a	n/a	20	20	20	20	20	20	20
20	17	9						1			N	Y	N	16	16	16	17	18	20	20
21	77	10									N	n/a	n/a	20	20	20	20	20	20	20

4.0 CONCLUSIONS AND RECOMMENDATIONS

The August, 1989 commercial operations of MV Lucien Paquin in Foxe Basin, N.W.T. were typical of operations in an area of the Arctic which has traditionally seen a relatively high level of shipping activity, and the results of the field trial are considered largely representative of this component of the Eastern Arctic sealift.

This section presents a summary of the main conclusions and recommendations developed during the study. Conclusions cover many different aspects of the ice regime system; some comments are general in nature, and others are very specific. They have therefore been grouped into three categories: Ice Regime System, General; Ice Charts; and Decision Numeral Calculations. Recommendations are made throughout.

4.1 Ice Regime System, General

Overall, the ice regime system was found to be a logical and workable means of administering regulatory guidance, and completely compatible with the principles of safe navigation employed as a matter of course by the master and his officers.

Ice conditions in Foxe Basin were characterized by a predominance of strips and patches of closely packed, first-year drift ice amidst open water. These strips and patches were themselves much too small to appear as individual ice regimes at the synoptic scale used for the AES ice analysis charts. Conditions were therefore depicted on these charts as larger areas of some average concentration of ice, with the presence of strips and patches of up to nine tenths concentration indicated within the regime. Observed ice regimes documented during the voyage were for the most part compatible with conditions depicted on charts received on the vessel bridge. These charts, supported by conventional marine radar and visual observations, were seen to be adequate to support the ice regime system.

For many regimes shown on the ice charts, Type 'A' was the minimum class of ship which would have been permitted to operate within their boundaries under the proposed regulations. With one minor exception MV Lucien Paquin, a Type 'B' vessel, did not enter these regimes. Most of the remaining regimes were accessible even to Type 'E' ships. Observed data show that during transit between ports of call, the vessel did not enter into any small, local ice regimes which would have generated negative decision numerals. Evasive actions resulting from such encounters were taken independently of the ice regime system, and indicate that the system would not in this case have contributed to any conflict between safe navigation and the commercial objective of proceeding as efficiently as possible without compromising the safety of ship and crew.

It is therefore concluded that for ice regime charts produced at AES, it is appropriate to calculate MEC based on the primary egg code describing a regime. Strips and patches, where present, are to be accounted for by the mariner in his consideration of navigation variables as required under the proposed regulations. These variables include ship manoeuvrability, ice hazard detection equipment on hand, weather conditions and the probability of change in ice conditions.

4.2 Ice Charts

The accuracy and timeliness of daily analysis charts produced at the AES Ice Centre were adequate for the purposes of the ice regime system, and this trial has reinforced the idea that the analysis chart could be adapted to support the regulatory system. Required modifications include the addition of a minimum entry criteria designator, supported by an indication of the extent to which decay and/or ridges and hummocks are present in the ice. The latter two parameters are required in

order that a mariner may know what factors have been accounted for in the minimum entry criteria calculation, so that he may know whether or not actual ice conditions were adequately represented. If they were not, then he may be required to reassess the decision numeral applicable to his ship.

Current MANICE symbology provides a means to denote these parameters, however the information is normally included only on observed charts generated during field reconnaissance, and is not routinely given on the daily ice analysis charts.

Recommendation # 1

It is recommended that in support of the ice regime system, symbology for MEC, ice decay and relative roughness, where the latter two are known, be included with each egg code on ice analysis charts as follows:

Where:

M = Minimum Entry Criteria
(E,D,C,B,A,CAC4,CAC3 or CAC2)
m = MANICE Code for Stage of Melt
(a value of 4 or higher indicates a minimum 1/10 thaw holes, which value corresponds to the minimum criteria for ice decay recommended in Cameron et. al., 1989)
r = MANICE Code for Relative Roughness
(a value of H indicates relative roughness of 4-10/10)

and the remaining codes are those currently in use on ice analysis charts:

C_t = Total Concentration (reported in tenths)
$C_{a,b}$ = Partial Concentrations of Ice Types
$S_{a,b}$ = Stage of Formation of Ice Types
$F_{a,b}$ = Floe Size of Ice Types

The quality of ice charts received was consistently good, however there were a few instances where characters were illegible. This was attributed to the combination of a reduced scale chart produced by the facsimile receiver, and some normal blurriness in the print. In comparing original ice charts to field copies, it was found that readability was sometimes difficult where original characters were only 5-6mm in height. The use of reduced-scale facsimile printers is not unusual in the marine industry.

Recommendation # 2

It is recommended that all characters included on ice charts for transmission to ships at sea be drawn to a minimum of 8mm in height, and be reasonably bold.

4.3 Decision Numeral Calculations

The process of calculating decision numerals was clear and straightforward, with two minor exceptions both related to surface roughness. The first difficulty was found in the ice type multiplier adjustment for this parameter. For strips of decayed and unconsolidated first-year brash ice, which is characteristically rough, the decrement value of '-1' for the ice multiplier was not practical, and would not have been a reasonable restriction to place on operations of MV Lucien Paquin. The second minor difficulty was found in the cut-off value for the application of this adjustment. The regulations state that the multiplier must be reduced by 1 where 30% of the area of an ice type is deformed by ridges, rubble or hummocking. The 30% value is not consistent with the MANICE definitions for relative roughness which have are recommended above for incorporation into the ice regime chart.

Recommendation # 3

It is therefore recommended that in Schedule 2 of the proposed regulations, sub-section 2.(3) be re-written as follows:

> **"Where the total ice concentration in a regime is 6 tenths or greater and 4 tenths or more of the area of an ice type other than brash ice is deformed by ridges, rubble or hummocking the weights for that ice type, given in Table 1, shall be decreased by 1."**

This change will bring the cut-off point for the roughness adjustment into line with current MANICE standards, as described in Recommendation # 1, without detracting from the intent of the regulations.

5.0 REFERENCES

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APPENDIX A

Proposed Ice Regime Shipping Control System

N. B. This document is a proposal of the sub-committee on the update of the Arctic Shipping Pollution Prevention Regulations. It does not represent in any way the position of the Coast Guard.

PROPOSED REVISIONS TO THE ARCTIC SHIPPING POLLUTION PREVENTION REGULATIONS

SHIP CATEGORIZATION

ARCTIC CLASSES

CLASS CAC 1

1. An Arctic Class CAC 1 ship is a ship which
   - (a) is designed and constructed for the purposes of
     - (i) unrestricted navigation in Canadian Arctic waters; and
     - (ii) the management of large ice features near
       - (A) mobile offshore drilling units
       - (B) offshore installations
       - (C) terminals and
       - (D) other ships,
   - (b) complies with the standards of construction set out in Schedules 1, 3 and 4
   - (c) has on board;
     - (i) an operating manual to guide the master in the operation of the ship in ice,
     - (ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada,
   - (d) has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and
   - (e) has on board persons trained in
     - (i) the overall Arctic ice regime and climate,
     - (ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters,
     - (iii) the operation of any electronic and related equipment on board for the purposes of receiving and interpreting ice and weather information and
     - (iv) the regulatory regime as it applies to Canadian waters.

CLASS CAC 2

2. An Arctic Class CAC 2 ship is a ship which
   - (a) is designed and constructed
     - (i) for the purposes of unrestricted navigation in Canadian Arctic waters and

N. B. This document is a proposal of the sub-committee on the update of the Arctic Shipping Pollution Prevention Regulations. It does not represent in any way the position of the Coast Guard.

(ii) ice management within its structural capability
(b) is fitted with a hull girder stress monitoring system for the purpose of controlling the ramming process,
(c) complies with the standards of construction set out in Schedules 1, 3 and 4,
(d) has on board;
(i) an operating manual to guide the master as to the proper operation of the ship in ice,
(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada,
(e) has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and
(f) has on board persons trained in;
(i) the overall Arctic ice regime and climate,
(ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters,
(iii) the operation of any electronic and related equipment on board, for the purposes of receiving and interpreting ice and weather information and
(iv) The regulatory regime as it applies to Canadian waters.

CLASS CAC 3

3. An Arctic Class CAC 3 ship is a ship which
(a) is designed and constructed for
(i) the purposes of navigation in Canadian Arctic waters in accordance with Section 11,
(ii) ice management within its structural capability
(b) is fitted with a hull girder stress monitoring system for the purpose of controlling the ramming process,
(c) complies with the standards of construction set out in Schedules 1, 3 and 4,
(d) has on board;
(i) an operating manual to guide the master as to the proper operation of the ship in ice and
(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada,
(e) has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and
(f) has on board persons trained in
(i) the overall Arctic ice regime and climate
(ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters
(iii) the operation of any electronic and related equipment on board for the purposes of receiving and interpreting ice and weather information.
(iv) the regulatory regime as it applies to Canadian waters.

CLASS CAC 4

4. An Arctic Class CAC 4 ship is a ship which
(a) is designed and constructed for
(i) the purposes of navigation in Canadian Arctic waters in accordance with Section 11,

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(ii) ice management within its structural capability.

(b) complies with the standards of construction set out in Schedules 1, 3 and 4,

(c) has on board;

(i) an operating manual to guide the master as to the proper operation of the ship in ice and

(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada,

(d) has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and

(e) has on board persons trained in;

(i) the overall Arctic ice regime and climate

(ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters

(iii) the operation of any electronic and related equipment on board for receiving and interpreting ice and weather information and

(iv) the regulatory regime as it applies to Canadian waters.

TYPE SHIPS

TYPE A SHIP

5. A TYPE A ship is a ship which

(a) is a self-propelled ship that complies with the construction standards specified as Type A in Schedule [ ]. *[Existing CASPPR]*

(b) has on board

(i) an operating manual to guide the master in the operation of the ship in ice and

(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada,

(c) has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and

(d) has on board persons trained in

(i) the Arctic ice regime and climate as it affects the zones in which the ship is permitted to navigate under these Regulations,

(ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters

(iii) The operation of any electronic and related equipment on board for receiving and interpreting ice and weather information.

TYPE B SHIP

6. A TYPE B ship is a ship which

(a) is a ship that complies with the construction standards specified as Type B in Schedule [ ]. *[Existing CASPPR]*

(b) in the case of a self-propelled ship, has on board

(i) an operating manual to guide the master in the operation of the ship in ice and

(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada,

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(c) in the case of a self-propelled ship, has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and

(d) in the case of a self-propelled ship, has on board persons trained in;

(i) the Arctic ice regime and climate as it affects the zones in which the ship is permitted to navigate under these Regulations,

(ii) the recognition by visual and electronic means of relavant ice types found in Arctic waters and

(iii) the operation of electronic and related equipment for receiving and interpreting ice and weather information.

TYPE C SHIP

7. A TYPE C ship is a ship which

(a) is a ship that complies with the construction standards specified as Type C in Schedule [ ]. *[Existing CASPPR]*

(b) in the case of a self-propelled ship, has on board

(i) an operating manual to guide the master in the operation of the ship in ice and

(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada

(c) in the case of a self-propelled ship,has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and

(d) in the case of a self-propelled ship, has on board persons trained in;

(i) the Arctic ice regime and climate as it affects the zones in which the ship is permitted to navigate under these Regulations,

(ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters

(iii) the operation of any electronic and related equipment on board for receiving and interpreting ice and weather information.

TYPE D SHIP

8. A TYPE D ship is a ship which

(a) is a ship that complies with the construction standards specified as Type D in Schedule [ ]. *[Existing CASPPR]*

(b) in the case of a self-propelled ship, has on board

(i) an operating manual to guide the master in the operation of the ship in ice and

(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada

(c) in the case of a self-propelled ship,has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means

(d) in the case of a self-propelled ship, has on board persons trained in;

(i) the Arctic ice regime and climate as it affects the zones in which the ship is permitted to navigate under these Regulations,

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(ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters
(iii) the operation of any electronic and related equipment on board for receiving and interpreting ice and weather information.

TYPE E SHIP

9. A TYPE E ship is a ship which
(a) is a ship that complies with the construction standards specified as Type E in Schedule [ ] *[Existing CASPPR]*
(b) in the case of a self-propelled ship, has on board
(i) an operating manual to guide the master in the operation of the ship in ice and
(ii) a manual describing the operating services and regulatory regime for the Arctic waters of Canada
(c) in the case of a self-propelled ship,has on board facsimile equipment for receiving ice and weather maps transmitted by electronic means and
(d) in the case of a self-propelled ship, has on board persons trained in;
(i) the Arctic ice regime and climate as it affects the zones in which the ship is permitted to navigate under these Regulations,
(ii) the recognition by visual and electronic means of relevant ice types found in Arctic waters
(iii) the operation of any electronic and related equipment on board for receiving and interpreting ice and weather information.

NAVIGATION SAFETY

[Note: Section 10 would be inserted in the collision regulations]

10. Every ship in Arctic waters shall at all times proceed in a safe speed so that she can take proper action to avoid unsafe collision with ice and , if necessary, be stopped within a distance appropriate to the prevailing conditions. In determining a safe speed the following factors shall be among those taken into account:
(a) By all ships;
(i) the category of the ship,
(ii) weather, visibility, ice or sea conditions,
(iii the power, and manoeuvring capability of the ship with special reference to the stopping distance and the turning ability in the prevailing conditions and
(iv) the elapsed time since the on board ice information was collected.
(b) Additionally, by ships fitted with electronic ice detection equipment:
(i) the characteristics, efficiency and limitations of that equipment,

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(ii) any constraints imposed by the range scales of that equipment,
(iii) the effect of weather, ice or sea conditions on that equipment.

(c) Additionally by ships fitted with electronic and other means of receiving ice data from external sources:
(i) the elapsed time since the data was obtained at source.
(ii) the quality of the data in terms of its resolution and the differentiation between of ice types.

ICE REGIMES

11. (1) *Subsection 6 (2) of the existing regulations*
Subject to subsections (2), (3) and (4), no ship of a category set out in Column I of an item of Schedule [VIII], carrying oil in excess of 453 m3, shall navigate in any zone set out in the heading of any other column of that item
(a) where the words "No Entry" are shown in that Column of that item; and
(b) where a period of time is shown in that Column of that item, except during that period of time.

Subsections (2) and (3) would replace subsections 6. (3) of the existing regulations
11. (2) Notwithstanding subsection (1), where in a Shipping Safety Control Zone or part of a Zone the ice regime determined
(a) in accordance with ice information issued by the Coast Guard or
(b) by means of ice information obtained from sources other than the Coast Guard,
is such that the Decision Numeral for a ship, determined as set out in Schedule 2, is less than zero that ship shall not navigate in that Zone or part of the Zone and the ice conditions shall be reported immediately to the Coast Guard.

11. (3) Notwithstanding subsection (1), where, by means of
(a) ice information issued by the Coast Guard or
(b) by means of ice information obtained from sources other than the Coast Guard,
a route is identified through a Shipping Safety Control Zone or part of a Zone in which the Decision Numeral or Numerals for that ship in the ice regime or regimes on that route are not less than zero the ship may navigate on that route provided that
(i) the master has taken account of
(A) the manoeuvring characteristics of the ship and suitable escort, if any,
(B) the operating characteristics of any equipment on board designed for the purpose of detecting ice hazards,
(C) the probability of the change in the ice conditions during the intended transit and

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(D) weather conditions,

(ii) before transit, a message, containing
- (A) the category of the ship and escort if any,
- (B) a description of the route,
- (C) a description of the ice regime or regimes on the route with the Decision Numerals and
- (D) a statement that subparagraph (i) has been complied with,

is sent to a Coast Guard Ice Operations Centre, and

(iii) an after action report, containing
- (A) a copy of the ice information used and
- (B) a summary description of the transit,

is sent within 30 days to a Coast Guard Ice Operations Centre.

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SCHEDULE 2

PROPOSED ICE REGIME SHIPPING CONTROL SYSTEM

Refer to Section 11 of the Proposed regulations

INTERPRETATION

1. In this schedule,

The **"Ice terminology"** is that set out in the World Meteorological Organisation Publication; WMO Sea-Ice Nomenclature, reference WMO/OMM/BMO-No. 259, as of March 1985.

"Decayed Ice" means

(a) second year ice
(b) thick first year ice and
(c) medium first year ice

which

(i) is flooded over part of its surface with 30% thaw holes formed or
(ii) is rotten ice.

" suitable escort" means a ship which

(a) is of a higher category than the ship being escorted and
(b) is not a Type B, C, D or E ship.

"Ice Numeral" means a number calculated in accordance with section 3.

"Decision Numeral" means a number calculated in accordance with section 4.

ICE TYPE WEIGHTING

2. (1) Ice types shall have weights relating to each category of ship as set out in Table 1.

2. (2) For the purposes of this section open water is an ice type.

2. (3) Where the total ice concentration in a regime is 6 tenths or greater and 40 % or more of the area of an ice type other than brash ice is deformed by ridges, rubble or hummocking the weights for that ice type, given in Table1, shall be decreased by 1.

2. (4) Where ice is decayed ice the weights for that ice type, in Table 1, may be increased by 1.

ICE NUMERAL

3. (1) The Ice Numeral for an ice regime in any Shipping Safety Control Zone or part of a zone shall be the sum of the products of

(a) the concentration in tenths of each ice type and
(b) the ice type weight relating to the category of the ship in question.

DECISION NUMERAL

4. (1) Subject to subsection (2) the Decision Numeral is the Ice Numeral calculated in accordance with Section 3.

4. (2) Where a ship has a suitable escort Ice Numeral calculated in accordance with section 3 shall be increased by 5 to obtain the Decision Numeral.

TABLE 1

ICE TYPE MULTIPLIERS FOR SHIP CATEGORIES

SECTION 2 OF SCHEDULE 2

	SHIP CATEGORY-->	TYPE E	TYPE D	TYPE C	TYPE B	TYPE A	CLASS CAC4	CLASS CAC3
ICE TYPE	ICE TYPE SYMBOL	MULTIPLIER	MULTIPLIER	MULTIPLIER	MULTIPLIER	MULTIPLIER	MULTIPLIER	MULTIPLIER
OPEN WATER	OW	2	2	2	2	2	2	2
GREY ICE	G	1	2	2	2	2	2	2
GREY WHITE	GW	- 1	1	1	1	2	2	2
THIN FIRST YEAR FIRST STAGE	THFY1	- 1	- 1	1	1	2	2	2
THIN FIRST YEAR SECOND STAGE	THFY2	- 1	- 1	- 1	1	2	2	2
MEDIUM FIRST YEAR	MFY	- 2	- 2	- 2	- 1	1	2	2
THICK FIRST YEAR	TFY	- 3	- 3	- 3	- 2	- 1	1	2
SECOND YEAR	SY	- 4	- 4	- 4	- 4	- 3	- 2	1
MULTI-YEAR	MY	- 4	- 4	- 4	- 4	- 4	- 3	- 1

APPENDIX B

WMO Symbology and IDIADS Database Codes

APPENDIX B

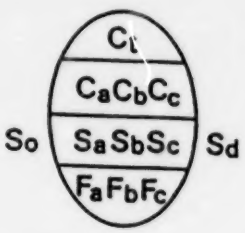
WMO Symbology and IDIADS Database Codes

List of Tables

B.1 International Sea Ice Symbols

B.2 Table of Entry Field Definitions, Criteria and Coding
(This table is labelled as Table A.1)

THE MAIN SYMBOLS



Ct	- Total concentration of ice in area, reported in tenths.
Ca Cb Cc	- Partial concentration in tenths of thickest (Ca), second thickest (Cb), and third thickest (Cc) ice types with Ca, Cb, and Cc 1/10 or more. If only one thickness type present Ca equals Ct and the second level is left blank.
Sa Sb Sc	- Stage of development (age) of ice concentration reported by Ca, Cb, and Cc.
Fa Fb Fc	- Predominant form of ice (floe size) corresponding to Sa, Sb, and Sc respectively.
So Sd	- Development stage (age) of remaining ice types. So if reported is a trace of ice type thicker/older than Sa. Sd is a thinner ice type which is reported when there are four or more ice thickness types.

Fa Fb Fc
Form of Ice (width)

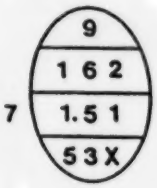
0	Pancake	
1	Brash	
2	Ice Cakes	- < 20 m
3	Small floe	- 20-100 m
4	Medium floe	- 100-500 m
5	Big floe	- 500-2000 m
6	Vast floe	- 2-10 km
7	Giant floe	- > 10 km
8	Fast Ice	
9	Icebergs	
X	No Form	
C	Ice is in strips in which concentration is C.	

Sa So Sc
Stage of Development (thickness cm)

1	New	- < 10 cm
2	Nilas	- < 10 cm
3	Young	- 10-30 cm
4	Grey	- 10-15 cm
5	Grey-white	- 15-30 cm
6	First Year	- > 30 cm
7	Thin First Year/White	- 30-70 cm
1.	Medium First Year	- 70-120 cm
4.	Thick First Year	- > 120 cm
7.	Old	
8.	Second Year	no
9.	Multi-year	defined
△	Icebergs	ranges

Note: All ages to left of "." are decoded from table as having "." (see example).

EXAMPLE



9 tenths ice present
1 tenth type 1. (medium first year), big floes (1. 1. 5 reading down)
6 tenths type 5 (grey-white ice), small floes (6 5 3 reading down)
2 tenths type 1 (new ice) no floe size
THERE IS a trace of ice type 7. (old ice)

Additional Symbols

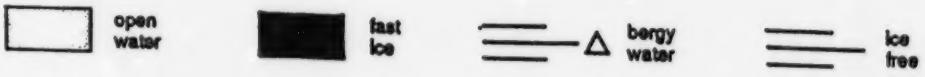


Table B.1
International Sea Ice Symbols

(after Atmospheric Environment Service, 1989)

TABLE A.1

Observation Log Data
Entry Field Definitions, Criteria and Coding

	FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
	SHIPNAME	Vessel Name	15	text	Name of vessel observation made from.
	DATE	yy/mm/dd	8	text	Date at time of observation.
	VOYNUM	Voyage No.	1	integer	Voyage number in annual arctic shipping season, used to group sequential observations, New number assigned following each port of call.
ENTRY					RECORD BOOKEEPING INFORMATION:
	ENUM	Entry No.	3	integer	Each single or grouped observation is numbered in ascending order, beginning with number 1, the first observation for a particular voyage.
	ET	Entry Type	1	H	Indicates that the data record (row) of the log contains a series of ice and environmental condition observations, made at regular 60 min. intervals.
				E	Indicates that the data in that record, and any following records identified by the same entry number, constitutes the description of an event. Events are recorded on an ongoing basis as they occur.
	GMT, EVENTGMT	(Greenwich Mean Time)	4,4	text	Time at which data in a particular record was observed.
NAVIGATION					DATA COLLECTED IN CONJUNCTION WITH THE REGULAR 60 min. ICE AND ENVIRONMENTAL CONDITION OBSERVATION:
	POSN	Latitude (north)	4	integer	Ships position as given by JRC Satelite Navigator (SatNav).
	POSW	Longitude (west)	5	integer	Ships position as given by JRC SatNav.
	COURSE	Compass Heading	3	integer	Ships heading as given by helm order.
	SPEED	Knots	2	integer	Ship speed as given by JRC SatNav.
	CMG	Course Made Good	3	integer	Using ships position data, these values are internally calculated by the database software for the preceeding 60 min. interval.
	DMG	Distance	2	integer	

TABLE A.1 (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

	FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
METORO-LOGICAL					DATA COLLECTED IN CONJUNCTION WITH THE REGULAR 60 min. ICE AND ENVIRONMENTAL CONDITION OBSERVATION:
	TEMPDRY	Dry Bulb Temperature	5	decimal	In degrees celsius.
	TEMPWET	Wet Bulb Temperature	5	decimal	In degrees celsius.
	TEMPSEA	Sea Surface Temperature	5	decimal	In degrees celsius.
	PRESSURE	Barometric Pressure	4	integer	As read from barometer, in units of MBar.
	WINDSPD	Wind Speed	2	integer	True values of wind speed (knots) and direction, calculated from anemometer readings.
	WINDDIR	Wind Direction	3	integer	
	CLOUDCOVR	Cloud Cover	1	0 - 9	Tenths of cloud cover based on visual observation.
				0	Overcast.
				X	Visual observation impossible due to fog or darkness.
	PRECIP	Precipi-tation	2		Based on predominant condition over preceeding 60 min. interval.
				R	Rain
				W	Showers
				L	Drizzle
				F	Fog
				S	Snow
				Z	Freezing Precipitation
	SEAHT	Wave Height	2	integer	Average amplitude of waves or swell, in meters.
	SEAPER	Wave Period	2	integer	Average period of waves or swell, in seconds.
	SEACAPS	Whitecaps	2	1 - 3	Few - Many whitecaps.

TABLE A.1 (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

	FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
COVER		SEA ICE COVER			COVERAGE OF SEA SURFACE IN TENTHS, BASED ON AVERAGE CONDITIONS ENCOUNTERED DURING PRECEEDING 60 min. INTERVAL: Swath width for observation is a minimum of 3 n.mi. to either side of the vessel (higher for low concentrations) unless reduced by poor visibility.
	COVERTOT	Total Cover	2		
	COVERNI	New Ice	2		New ice forms up to light nilas (10 cm).
	COVERG	Grey Ice	2		10 - 15 cm.
	COVERGW	Grey-White	2		15 - 30 cm.
	COVERFY	First Year	2		30 cm - 2 m.
	COVEROI	Old Ice	2		Includes second-year and multi-year ice.
					FOR ALL SEA ICE COVER FIELDS:
				0 - 10	Tenths of Coverage (for 9+ use 9, with sum of partial concentrations = 10)
				FI	Fast Ice
				TR	Trace
				OW	Open Water
				BW	Bergy Water
				IF	Ice Free
FLOE SIZE					Predominant floe size over preceeding 60 min.
	COVERFLOE	First Year Ice Floe Size	1		
	OLDFLOE	Old Ice Ice Floe Size	1		
				0	Pancake
				1	Brash
				2	Ice Cake
				3	Small Floe (20 - 100 m diameter)
				4	Medium Floe (100 - 500 m)
				5	Big Floe (500 - 2000 m)
				6	Vast Floe (2 - 10 km)
				7	Giant Floe (> 10 km)
				8	Fast Ice

TABLE A.1 (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
FIRST YEAR CHARACTERISTICS				Characteristics of the most severe first year ice conditions (accounting for at least 30% of the total first year cover) encountered over the preceeding 60 min interval.
THICKNESS	First Year Ice	1	1 2 3 4	30 - 50 cm.; thin first year, first stage 50 - 70 cm.; thin first year, second stage 70 - 120 cm.; medium first year 120 - 200 cm.; thick first year
STRENGTH	First Year Ice	1	W S	Weak; Thaw holes present -> Refrozen Strong; Refrozen -> Extensive Puddling
RIDGES	Ridges Intersected	2	integer	Number of first year ridges intersected by the vessel having a minimum sail height of 1.0 m.
REGIME	Ice Regime Number	3	text	"Label" based on most recent classifications developed in support of CASPPR revisions.
ICEBERG DATA	GLACIAL HAZARDS PASSED	16	integer	A CATEGORIZED RUNNING TOTAL OF GLACIAL ICE HAZARDS PASSED WITHIN 12 n.mi. OF THE VESSEL (USUAL NIGHT RADAR RANGE SETTING) OVER THE PRECEEDING 60 min. INTERVAL: It is acknowledged that detection of growlers, either visually or by radar, is commonly limited to a range of 2 - 5 n.mi.
PT/STBD	Side Passed			Categorizes all hazards as having been passed to port or to starboard of the vessel.
IN/OUT	Passing Distance			Categorizes all hazards as having been passed inside or outside of 1/2 n.mi.
IB/GR	Size Classification			Categorizes all hazards as belonging to Growler or to Bergy Bit/Iceberg size classifications.

TABLE A.1 (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
ICEBREAKING				THE APPROXIMATE PORTIONS OF THE PRECEEDING 60 min. INTERVAL IN WHICH THE VESSEL WAS ENGAGED IN THE FOLLOWING MODES OF TRANSIT THROUGH ICE INFESTED WATERS:
ICEOPEN	% Time	2	integer	No contact with ice.
ICEPUSH	% Time	2	integer	Pushing through ice floes, including impacts which result in immediate floe fracture.
ICEBRK	% Time	2	integer	Active breaking of ice in a cusping fashion.
ICERAM	% Time	2	integer 99	Reverse/Ram cycles resulting in much reduced progress. Stopped.
IDENTIFI-CATION				DESCRIBES THE NATURE OF AN ICE REGIME PERTAINING TO AN INDIVIDUAL EVENT.
PORTID	Conditions to Port	5	text	The above noted conditions are divided into 3 sectors. Conditions ahead are those within the 10 degree sector which straddles the ships heading at the time of initial observation. Conditions to port and to starboard of that area, back to abeam of the vessel, are noted in the remaining two sectors. Each of the 5 characters which make up an entry for a particular sector describe a specific aspect of that condition. The alphabetic coding employed for a particular character is dependant on the the position of the character within the field as well as the values of any preceeding characters.
AHDID	Conditions Ahead	5	text	
STBDID	Conditions to Starboard	5	text	

TABLE A.1 (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
				AVAILABLE CODES FOR THE FIVE SEQUENTIAL CHARACTERS, FROM LEFT TO RIGHT AND BEGINNING WITH CHARACTER No. 1., ARE AS FOLLOWS:
	Event Type	No. 1	E	Ice Edge
			F	First Year Ice
			R	Ridge Remnant/Ridging
			M	Old (Multi-Year) Ice
			T	Fast Ice
			G	Glacial Ice
			X	Mix of ice types
			W	Open Water
			L	Lead
			V	Visual Indication (water sky, ice blink)
			I	Icebreaker Escort
			P	Pressure
			O	Outside Influence on Vessel Progress (ie. mechanical problems, prefered arrival time)
			A	Snow
	Hazard Size	No. 2		WHEN CHARACTER No. 1 = E, F, R, M or X:
			P	Pancake/Brash
			C	Ice Cake
			S	Small Floe
			M	Medium Floe
			B	Big Floe
			V	Vast Floe
			G	Giant Floe
			U	Unknown
			F	Floeberg
			R	Ridge Remnant
				WHEN CHARACTER No. 1 = I, P or O:
			B	Begin
			E	End
				WHEN CHARACTER No 1 = A:
			L	Level snow cover
			D	Drifted snow cover

TABLE A.1 (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
				WHEN CHARACTER No. 1 = L:
			1	25 m (lead width)
			2	50 m
			3	100 m
			4	200 m
			5	400 m
			6	800 m
			7	1600 m
			8	> 1 mi.
			9	> 2 mi.
	Extent	No. 3		WHEN CHARACTER No. 1 = E, F, R, M or X:
			integer	Coverage in tenths
			X	9+ tenths
			C	10 tenths
			T	Trace
			S	Strips and Patches
			U	Unknown Concentration
				WHEN CHARACTER No. 1 = I:
			L	Leading
			F	Following
				WHEN CHARACTER No. 1 = P:
			S	Vessel Slowed
			B	Vessel Beset
				WHEN CHARACTER No. 1 = A:
			integer	Average Thickness (cm x 10)

TABLE A.1. (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
	Condition	No. 4		WHEN CHARACTER No. 1 = F or X:
			integer	Tenths of ridging/rubble
			R	Discrete ridge or rubble feature
				WHEN CHARACTER No. 1 = M:
			integer	Average freeboard (meters)
				WHEN CHARACTER No. 1 = R:
			integer	Sail Height (meters)
				WHEN CHARACTER No. 1 = L:
			integer	Points off ships original head
				WHEN CHARACTER No. 1 = G:
			D	Drydocked
			P	Pinnacled
			H	Domed
			C	Picturesque
			T	Tabular
			W	Weathered
			B	Blocky

TABLE A.1 (continued...)

Observation Log Data
Entry Field Definitions, Criteria and Coding

FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
		No. 5		There remain many types of events possible beyond those listed for the first character of the identification field. For the most part these will indicate the presence of some unusual influencing factor, and will commonly require particulars to be recorded in the OBSERVATION LOG DIARY. In order to simplify and categorize these outside references to flag computerized search routines, the following descriptive codes are used (in the AHD sector only):
			A	Course alteration according to navigators planned route.
			S	Notes on factors which have influenced a strategic or tactical navigation decision, including the reception, quality, accuracy and utilization of SAR, SLAR, VIEWFAX, and FACSIMILE as appropriate.
			R	Notes on target detection problems experienced with various radars.
			J	JRC SatNav problems or comments.
			L	Indicates first detection was visual.
			V	Note explaining uncertainty in the visual identification of a hazard.
			M	Miscellaneous (no effect on vessel progress).

TABLE A.1 (continued...)

Observation Log Data

Entry Field Definitions, Criteria and Coding

FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
DETECTION				WHEREVER AN IDENTIFICATION ENTRY IS MADE WHICH REFERS TO A CHARACTERISTIC ICE CONDITION, THE DETAILS OF ITS LOCATION RELATIVE TO THE VESSEL ARE RECORDED.
RANGEDET	Range	2	decimal	Distance of ship from hazard (n.mi.), using radar or visual estimate as appropriate.
RESULT				AS THE RESULT OF AN ENCOUNTER WITH AN ICE CONDITION, THAT CONDITION IS EITHER PASSED OR CONTACTED:
RESTYPE	Type of Impact	1	D	Direct impact on stem.
			G	Grazing impact on bow side plating.
RESSEV	Severity of Impact	1		A relative scale based on the perception of the observer:
			L	Light
			M	Medium
			H	Heavy
MULTEV	Number of Impacts Since Last Record	2	integer	Multiple Impacts, Including Rams.
PHOTO	Photography Record			USED TO RECORD A SINGLE OR SERIES OF PHOTOGRAPHS RELATING TO A PARTICULAR EVENT:
FILM	Film No.	2	text	
FRAMEF	First Frame	2	integer	
FRAMEL	Last Frame	2	integer	

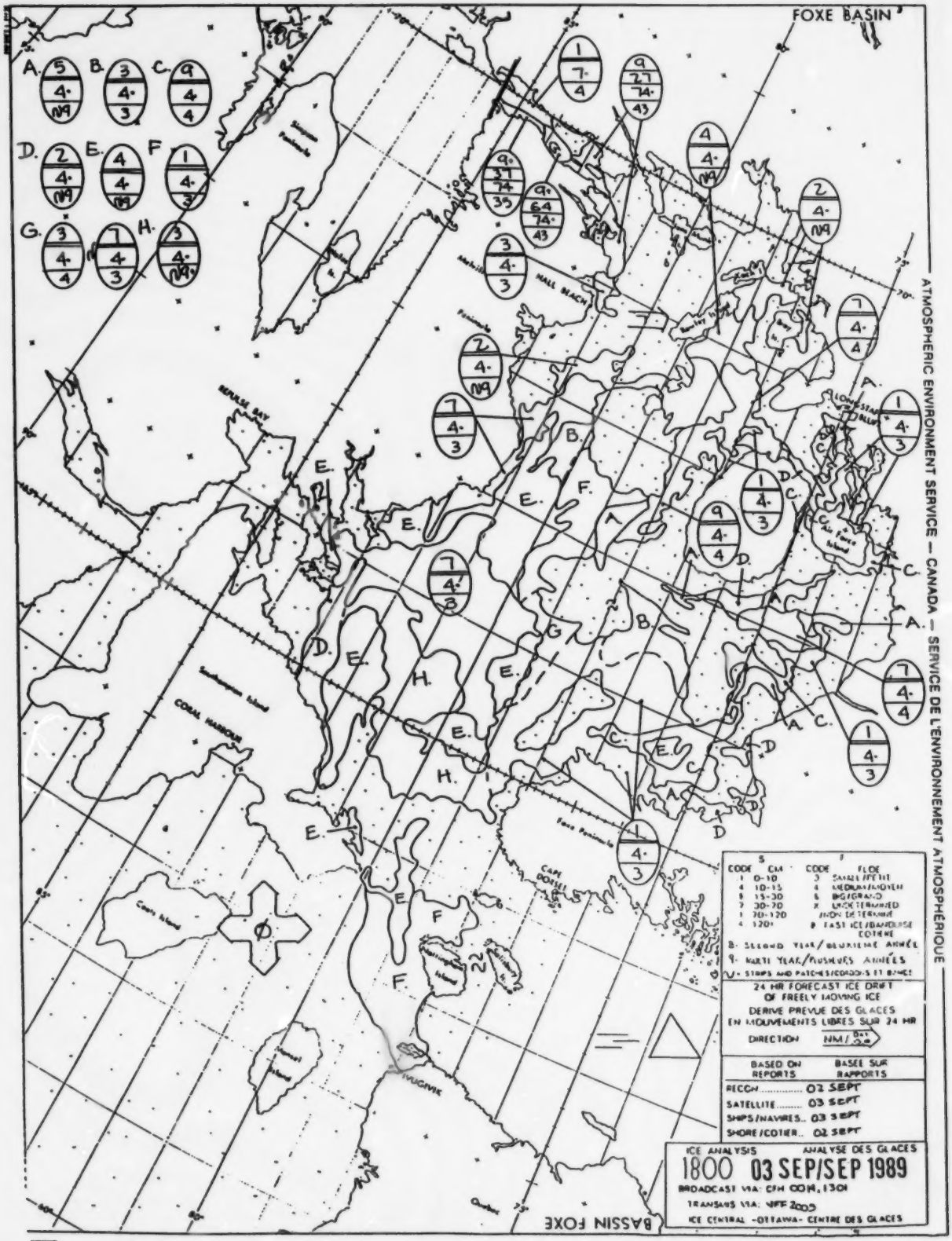
TABLE A.1 (continued...)

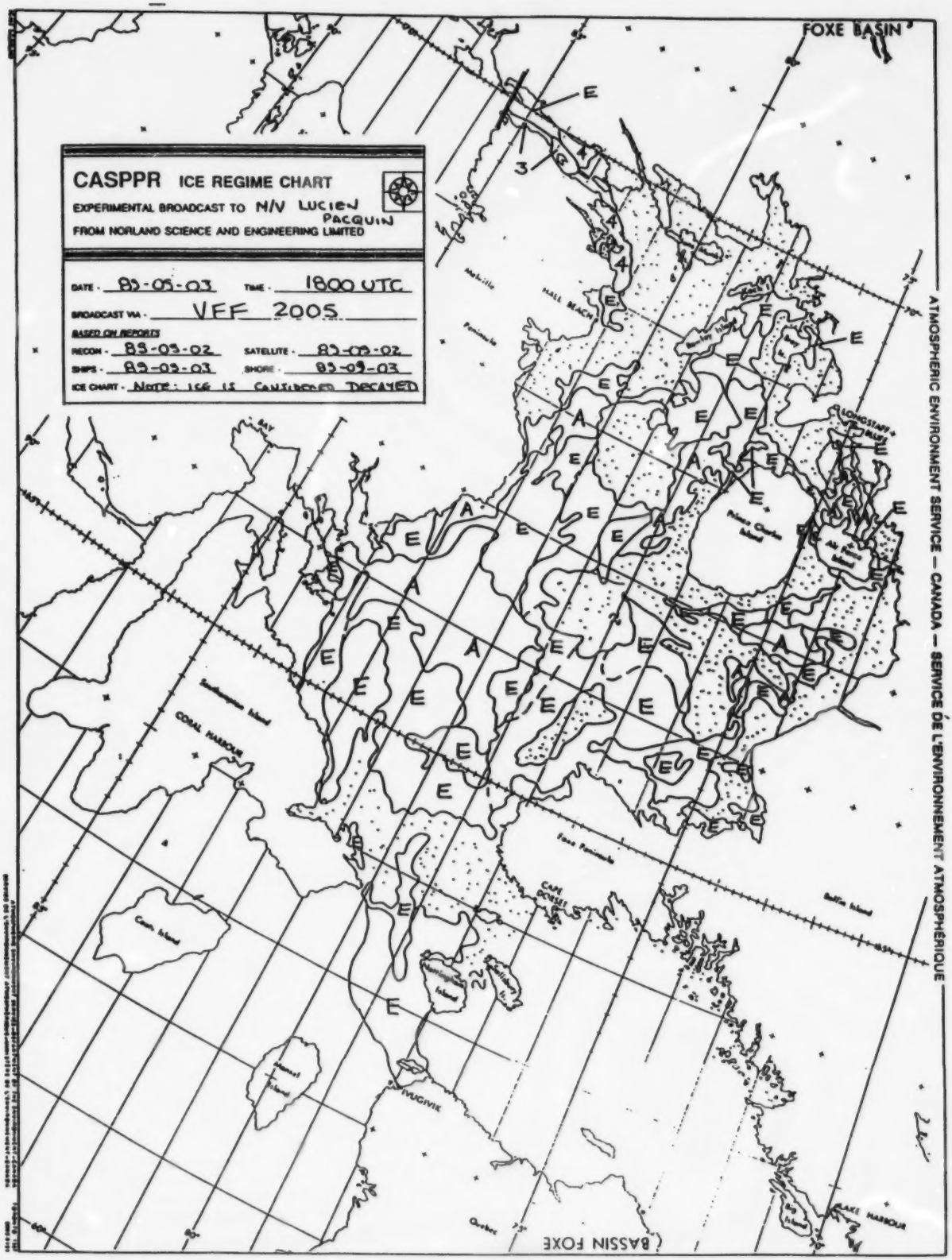
Observation Log Data
Entry Field Definitions, Criteria and Coding

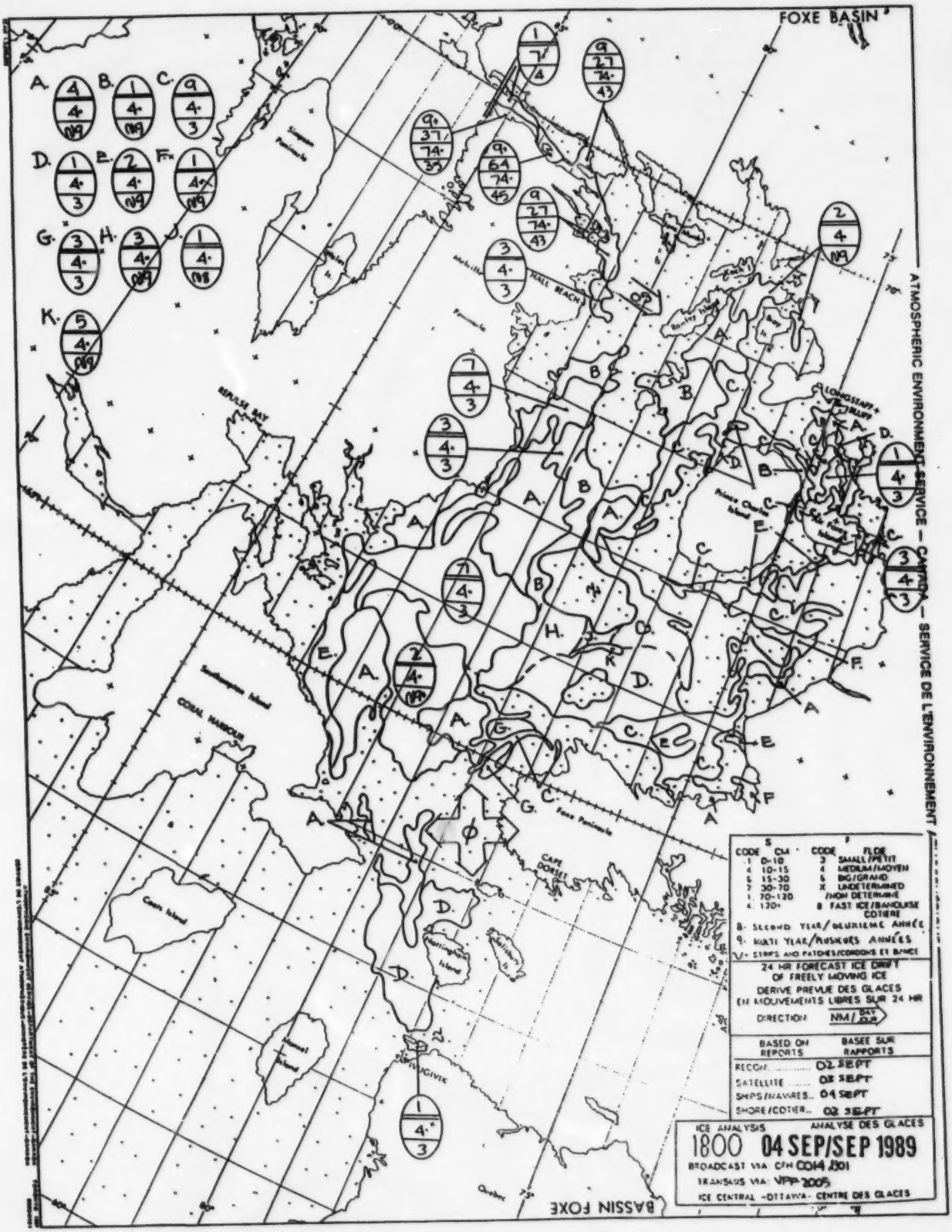
FIELD TITLE	DEFINITION	FIELD LENGTH	VALUE RANGE / CODING	ENTRY CRITERIA AND DETAILS
NAV AIDS	Aids to Navigation			A RECORD OF THE UTILIZATION OF NAVIGATIONAL AIDS, UPDATED WHENEVER CHANGED:
RADONE	Decca 3 cm. Radar	3	OFF	Radar is turned off.
RADTWO	Sperry 10 cm. Radar	3	integer	Radar is turned on and set at indicated range.
SLIGHTS	Foreward Search-Lights	3	ON OFF	Indicates operational status.
VISIBILITY	Prevailing Visibility	1	text	Based on the observers judgement visibility is updated whenever a change is noted. Due to fluctuations common in reduced visibility situations, as well as their perceived impact on navigational responses, visibility ranges are grouped and coded as follows:
			1	0 - 1/8 n.mi.
			2	> 1/8 - 1/2 n.mi.
			3	> 1/2 - 6 n.mi.
			4	> 6 n.mi.
			5	Dusk/dawn or flat light conditions.
			6	Darkness illuminated by moon and starlight.
			7	Darkness.
			8	Glare
REFERENCE	Diary Log Reference	1	Y	Indicates that additional information outside of that contained in the database exists for a particular event. This information is recorded in the OBSERVATION LOG DIARY, with entries corresponding to the appropriate event number.

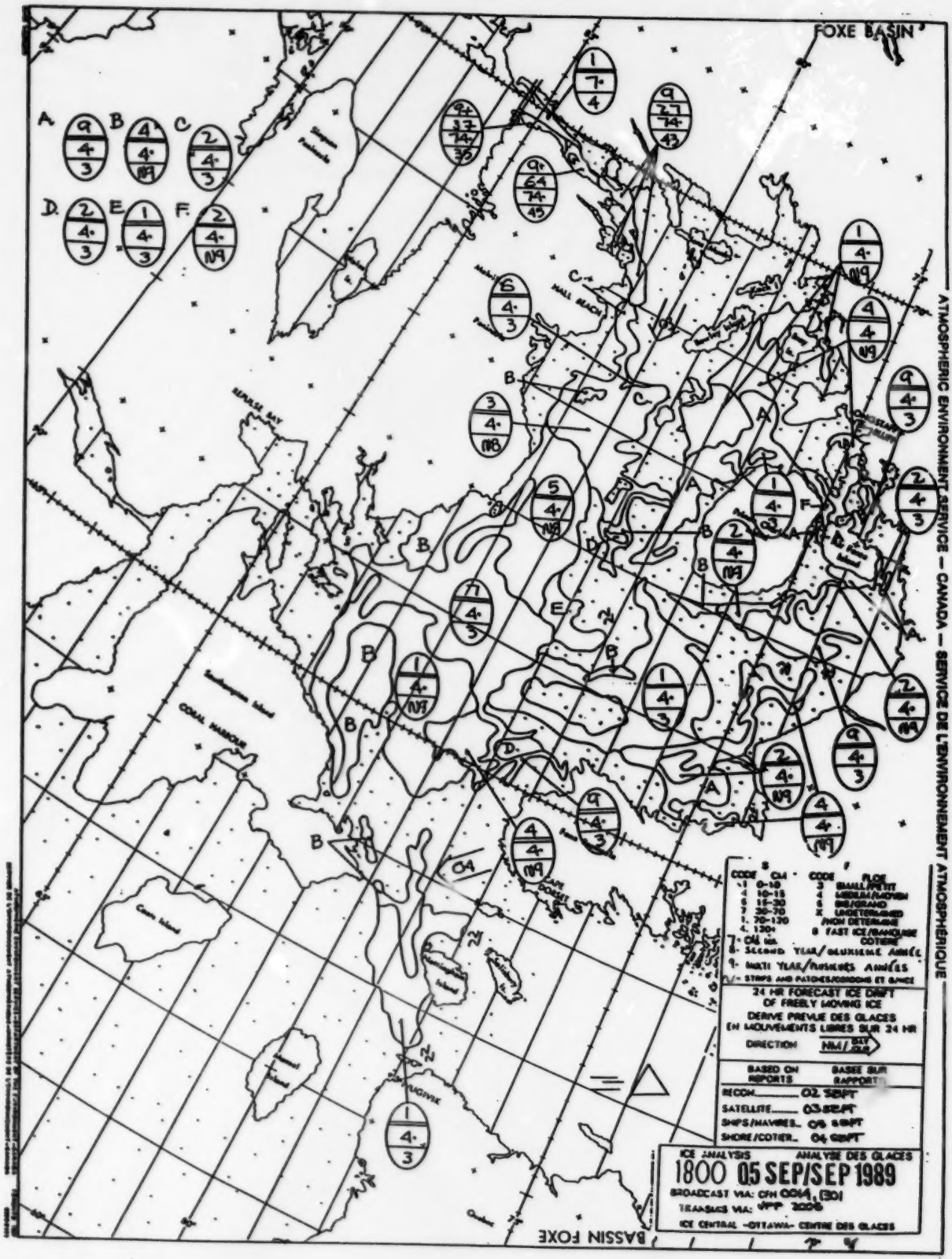
APPENDIX C

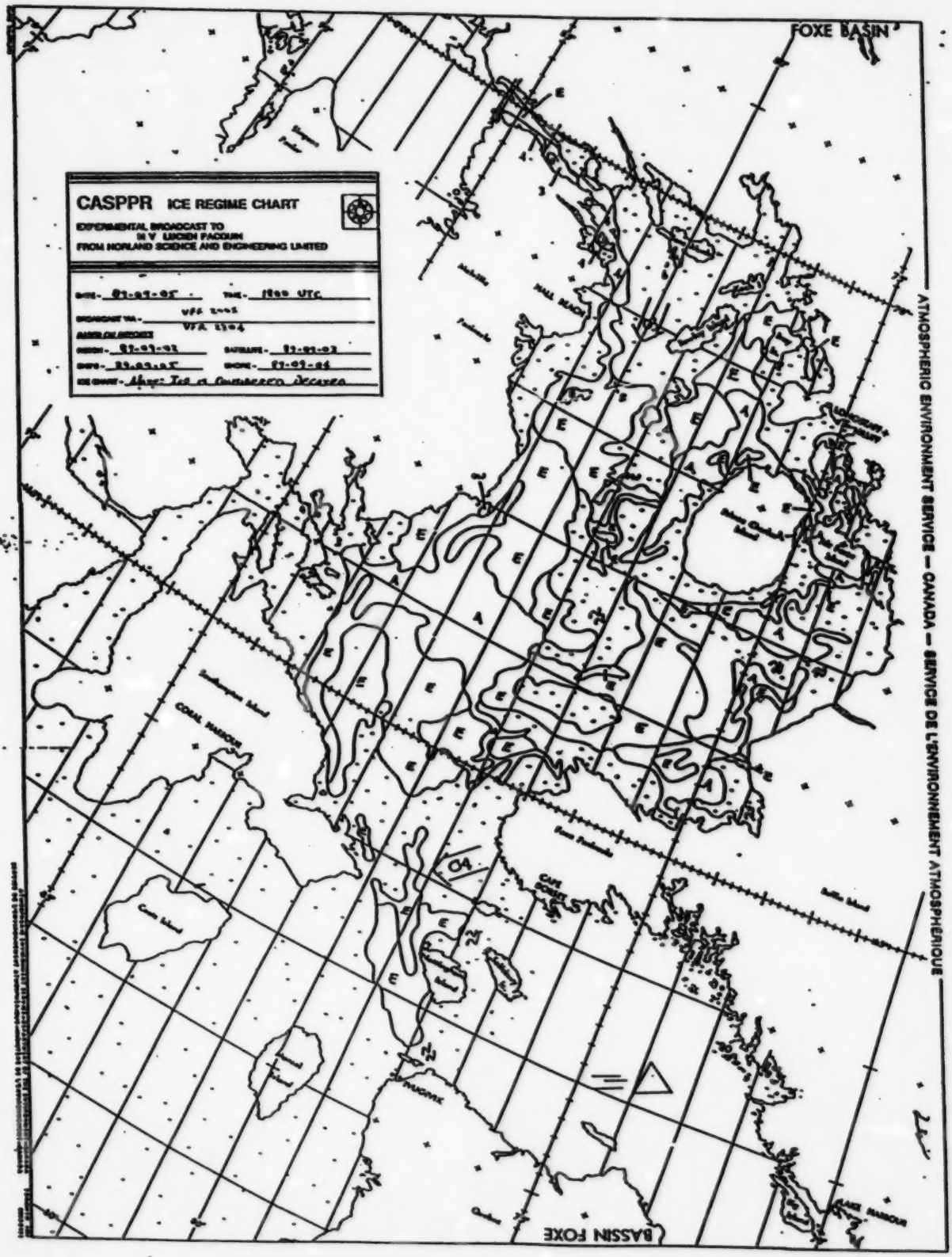
AES Ice Analysis and Experimental Ice Regime Charts

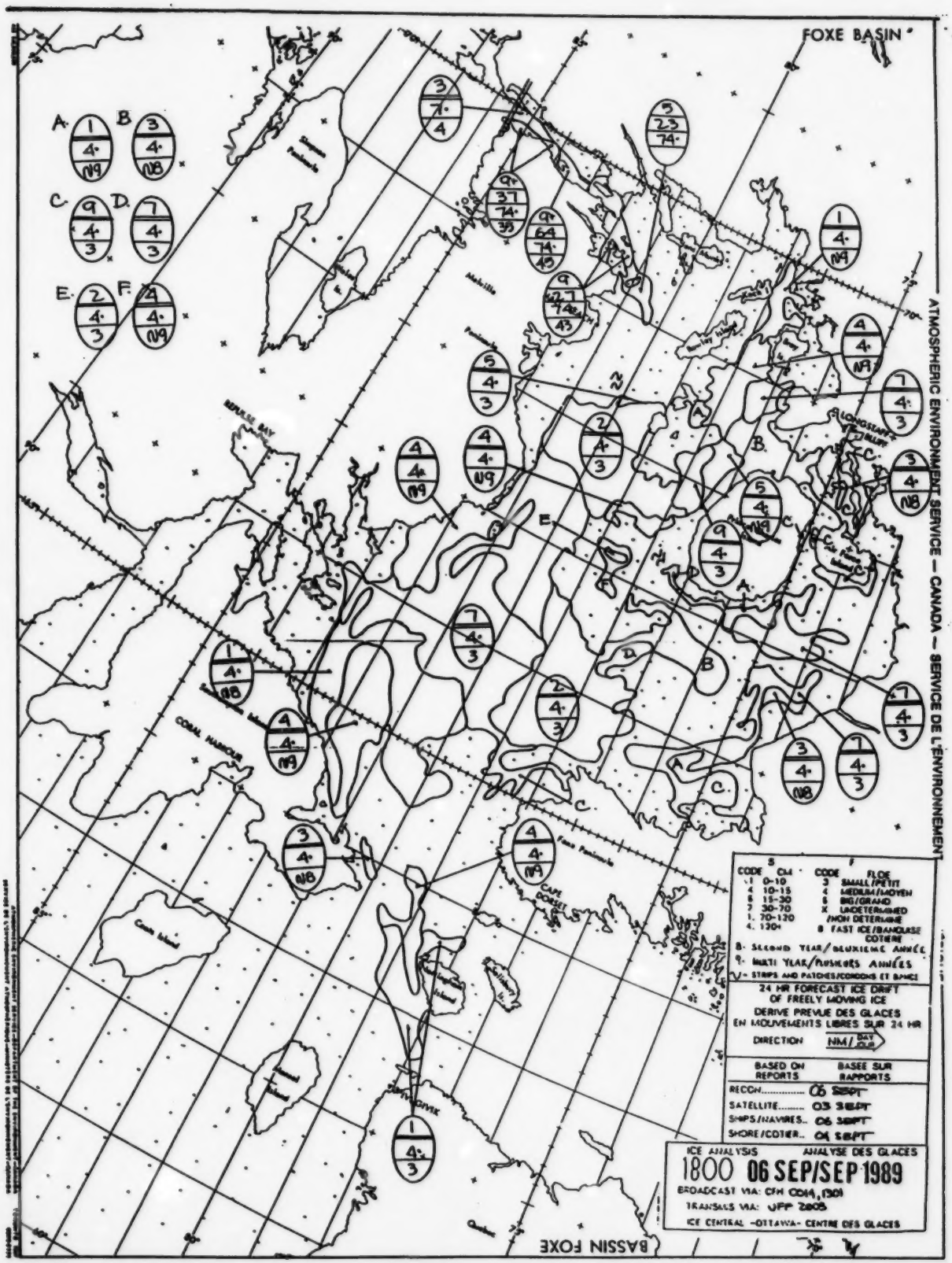

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE
HALL BEACH
COAL HARBOUR
CAPE DORSET
FROBISHER BAY
PUGNIRK
CODE CM
CODE FLOE
B- SECOND YEAR/DEUXIEME ANNÉE
M- MULTI YEAR/PLUSIEURS ANNÉES
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON ..... 02 SEPT
SATELLITE ..... 03 SEPT
SHIPS/NAVIRES.. 03 SEPT
SHORE/COTIER.. 02 SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 03 SEP/SEP 1989
BROADCAST VIA: CFH OOIM, 1301
TRANSAS VIA: WFF 2003
ICE CENTRAL -OTTAWA- CENTRE DES GLACES

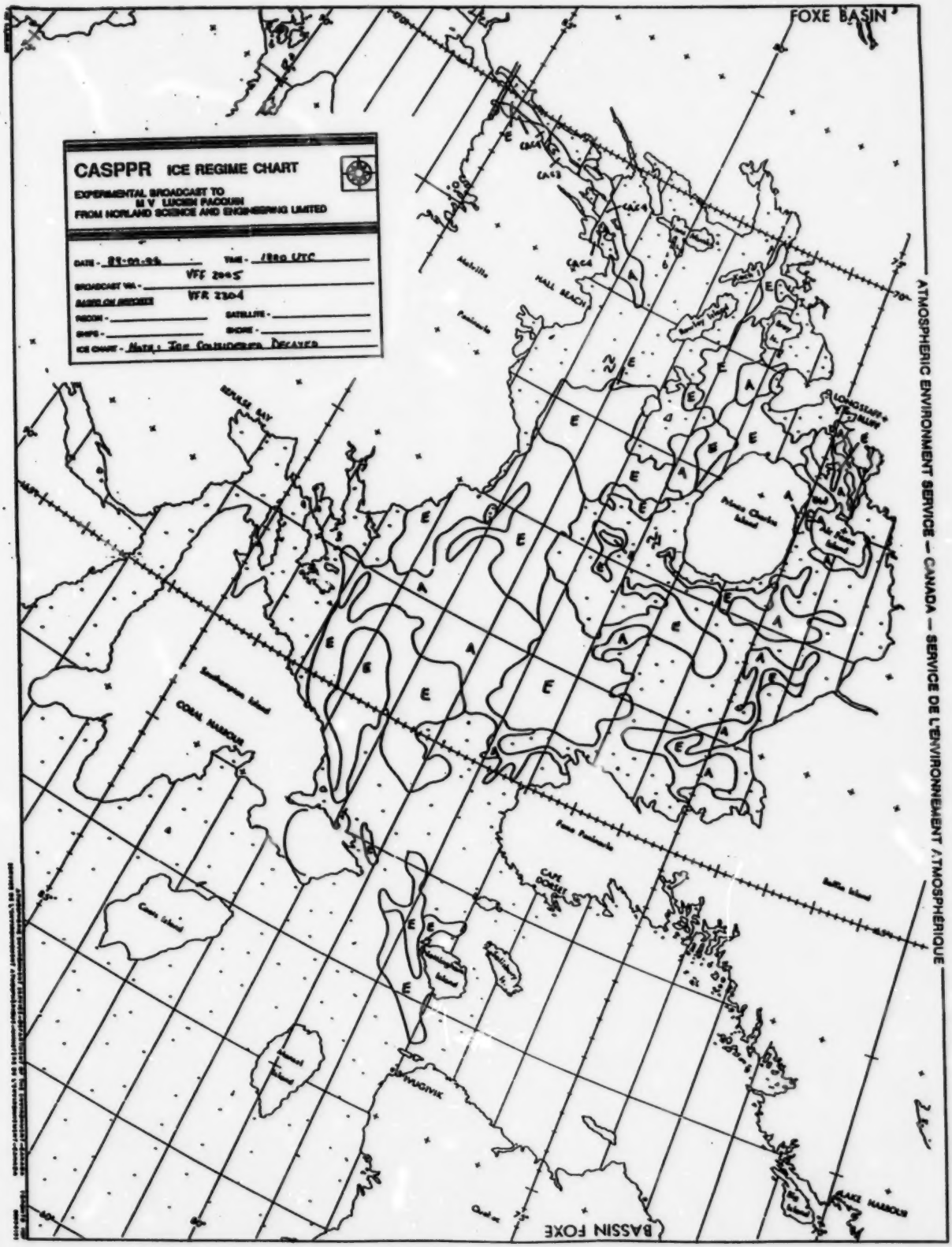

FOXE BASIN
CASPPR ICE REGIME CHART
EXPERIMENTAL BROADCAST TO N/V LUCIEN PACQUIN
FROM NORLAND SCIENCE AND ENGINEERING LIMITED
DATE - 89-05-03 TIME - 1800 UTC
BROADCAST VIA - VFF 2005
BASED ON REPORTS
RECON - 89-05-02 SATELLITE - 89-05-02
SHIPS - 89-05-03 SHORE - 89-05-03
ICE CHART - NOTE: 166 IS CONSIDERED DECAYED
COAL HARBOUR
Southampton Island
Coats Island
Mansel Island
Foxe Peninsula
Baffin Island
CAPE DORSET
HALL BEACH
LOMONOSOV RIDGE
LAKE HARBOUR
IVUGIVIK
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE

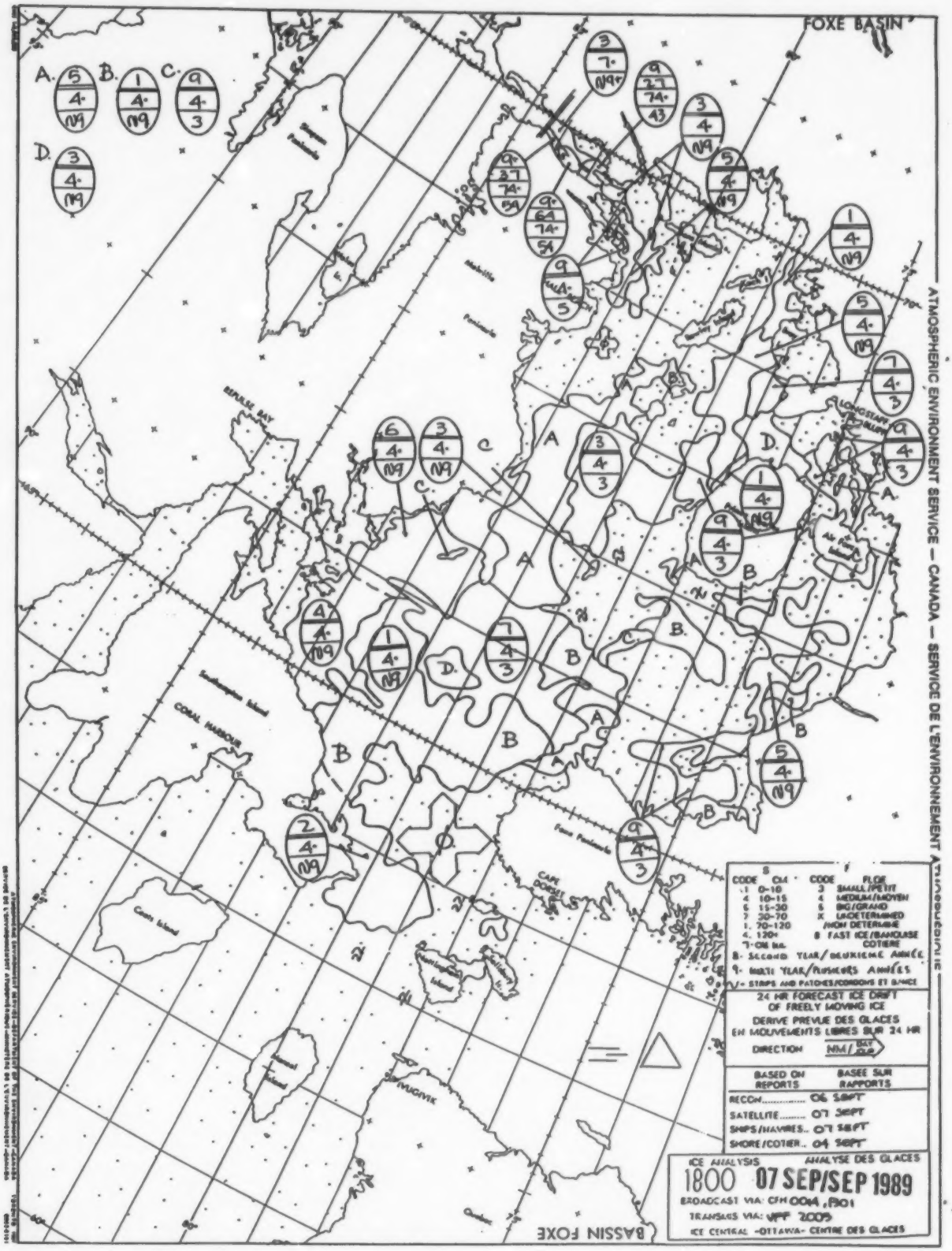

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE
COAL HARBOUR
CAPE DORSET
IVUJIVIK
LONGSTAFF BLUFF
PRINCE CHARLES ISLAND
Southampton Island
Coats Island
Nottingham Island
Mansel Island
Baffin Island
Foxe Peninsula
Melville Peninsula
PEARCE POINT
REPULSE BAY
Quebec
CODE CM
1 0-10
4 10-15
5 15-30
7 30-70
1 70-120
4 120+
CODE FLOE
3 SMALL/PETIT
4 MEDIUM/MOYEN
5 BIG/GRAND
X UNDETERMINED
/NON DETERMINE
8 FAST ICE/BANQUISE COTIERE
8- SECOND YEAR/DEUXIEME ANNÉE
9- MULTI YEAR/PLUSIEURS ANNÉES
V- STRIPS AND PATCHES/CORDONS ET BANCS
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
NM/DAY
KM/JOUR
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON. 02 SEPT
SATELLITE 02 SEPT
SHIPS/NAVIRES 04 SEPT
SHORE/COTIER 02 SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 04 SEP/SEP 1989
BROADCAST VIA C/N CO14 301
TRANSAUS VIA: VFP 2005
ICE CENTRAL -OTTAWA- CENTRE DES GLACES

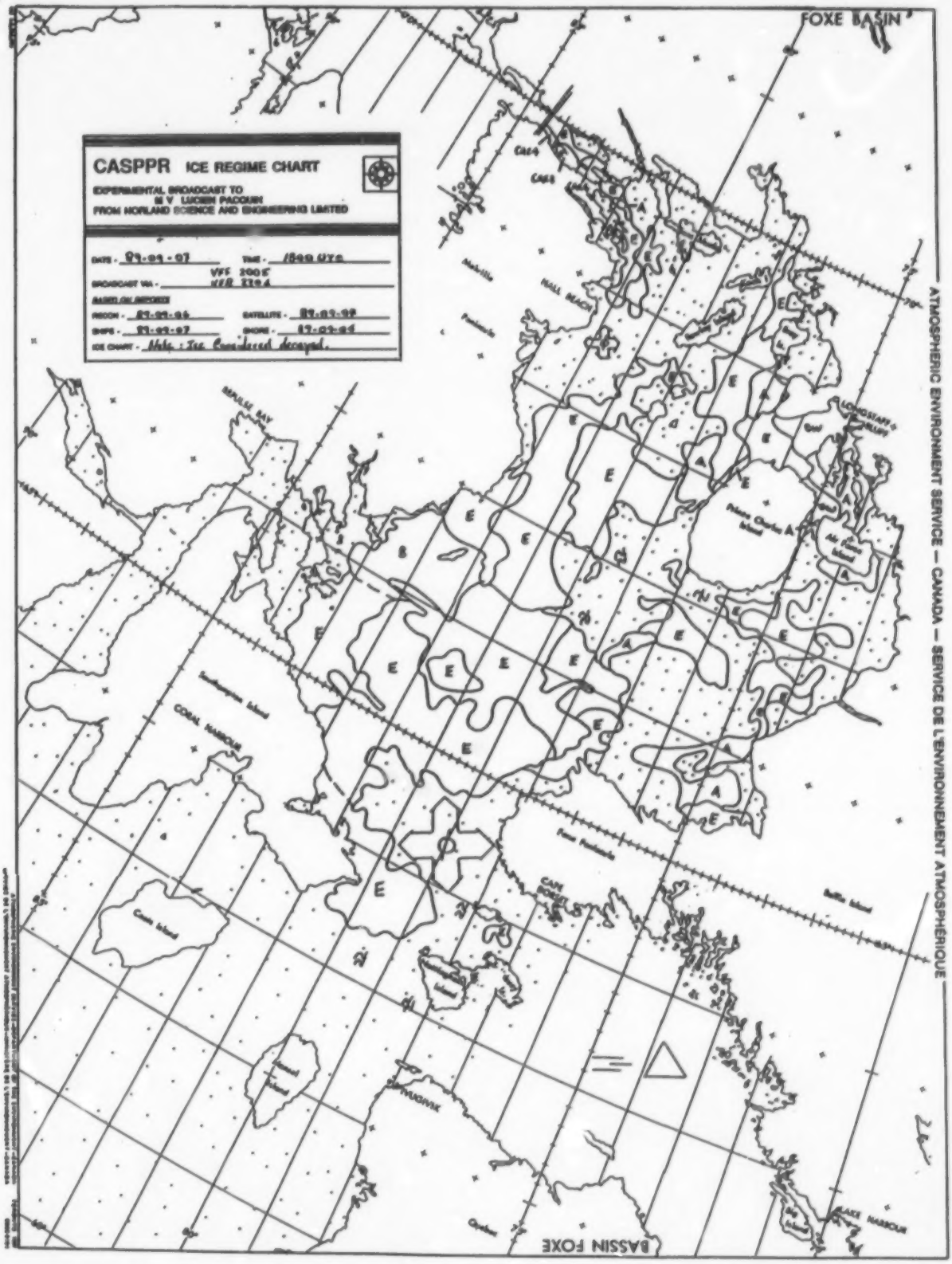

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE
CODE CM
CODE FLOE
24 HR FORECAST ICE DRIFT
OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES
EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON
BASSE SUR
RECON 02 SEPT
SATELLITE 03 SEPT
SHIPS/NAVIRES 04 SEPT
SHORE/COTIER 04 SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 05 SEP/SEP 1989
BROADCAST VIA: CFH 6014, 8301
TRANSMIS VIA:
ICE CENTRAL -OTTAWA- CENTRE DES GLACES

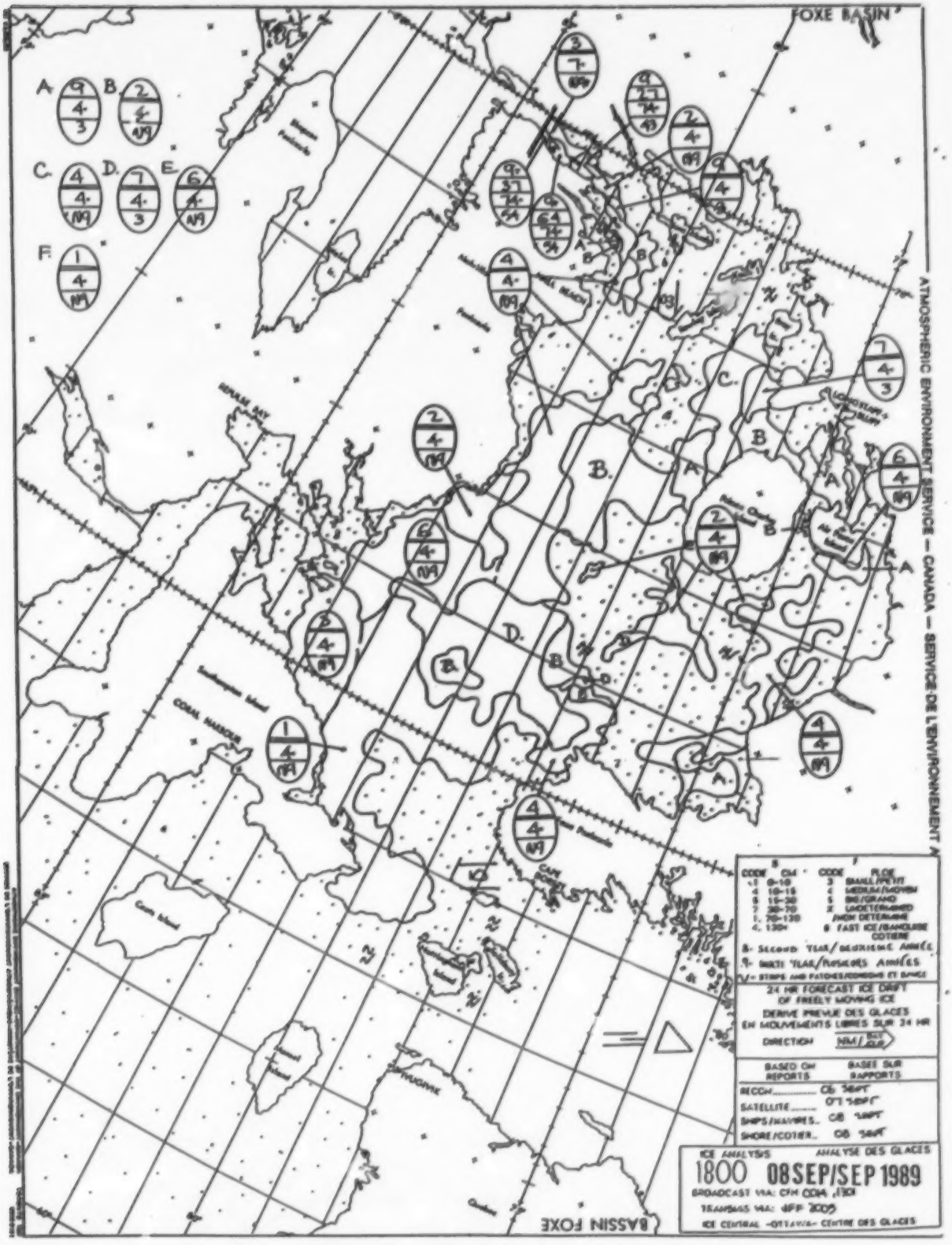

FOXE BASIN
CASPPR ICE REGIME CHART
EXPERIMENTAL BROADCAST TO
M V LUCIEN PACQUIN
FROM NORLAND SCIENCE AND ENGINEERING LIMITED
DATE- 91-09-05
TIME- 1900 UTC
VFA 2105
VFA 2104
VALID UNTIL
0600- 91-09-07
SATELLITE- 91-09-03
SHORE- 91-09-04
ICE CHART- Many Tel & Confidence Decrease
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHERIQUE
BASSIN FOXE

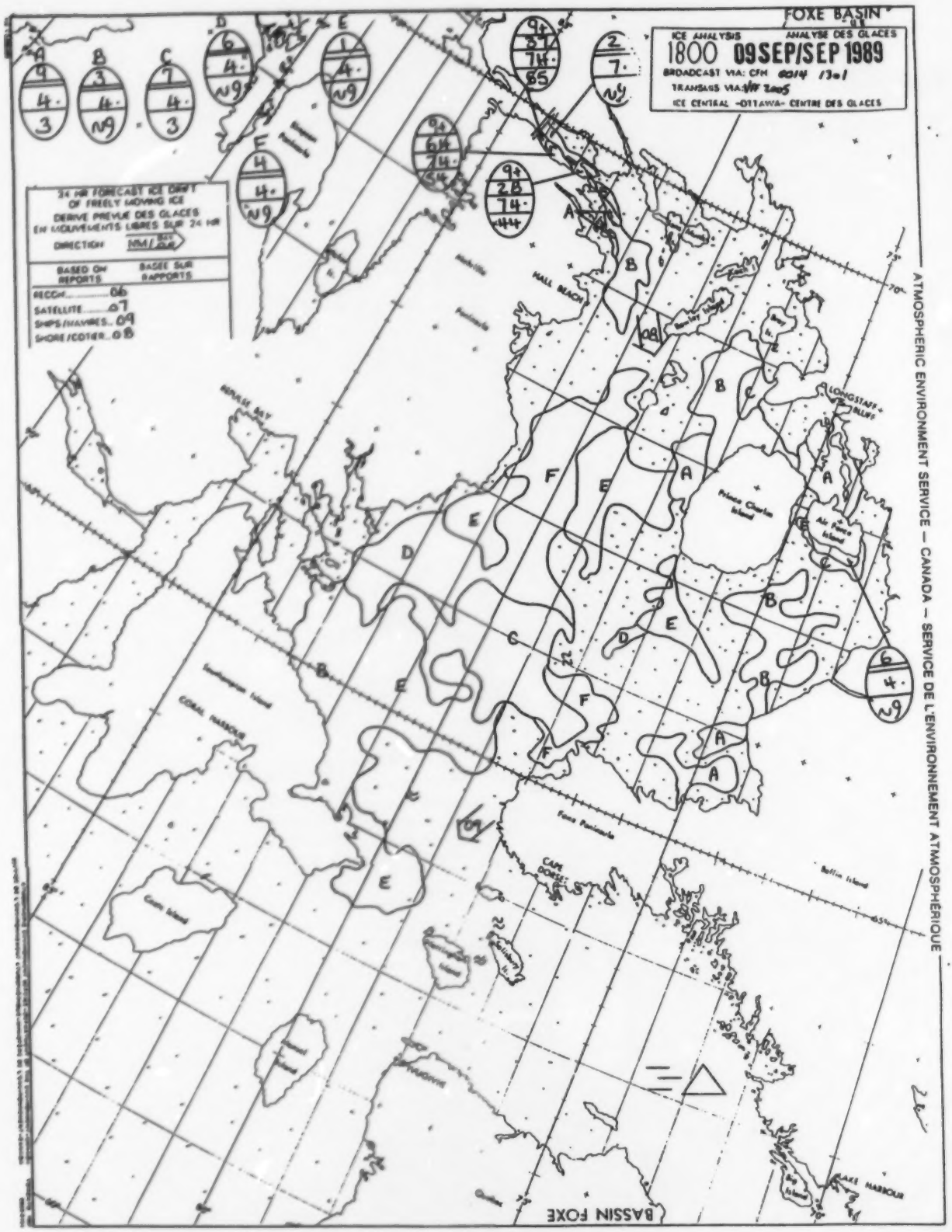

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT
CODE CM
0-10
10-15
15-30
30-70
70-120
120+
CODE FLOE
SMALL/PETIT
MEDIUM/MOYEN
BIG/GRAND
UNDETERMINED
/NON DETERMINE
8 FAST ICE/BANQUISE COTIERE
B- SECOND YEAR/DEUXIEME ANNÉE
9- MULTI YEAR/PLUSIEURS ANNÉES
V- STRIPS AND PATCHES/CORDONS ET BANCS
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON..... 06 SEPT
SATELLITE..... 03 SEPT
SHIPS/NAVIRES.. 06 SEPT
SHORE/COTIER.. 04 SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 06 SEP/SEP 1989
BROADCAST VIA: CFH CD14, 1301
TRANSALS VIA: UFP 2805
ICE CENTRAL -OTTAWA- CENTRE DES GLACES
REPULSE BAY
CORAL HARBOUR
CAPE DORSET
Coats Island
Southampton Island
Melville Peninsula
Foxe Peninsula
Baffin Island

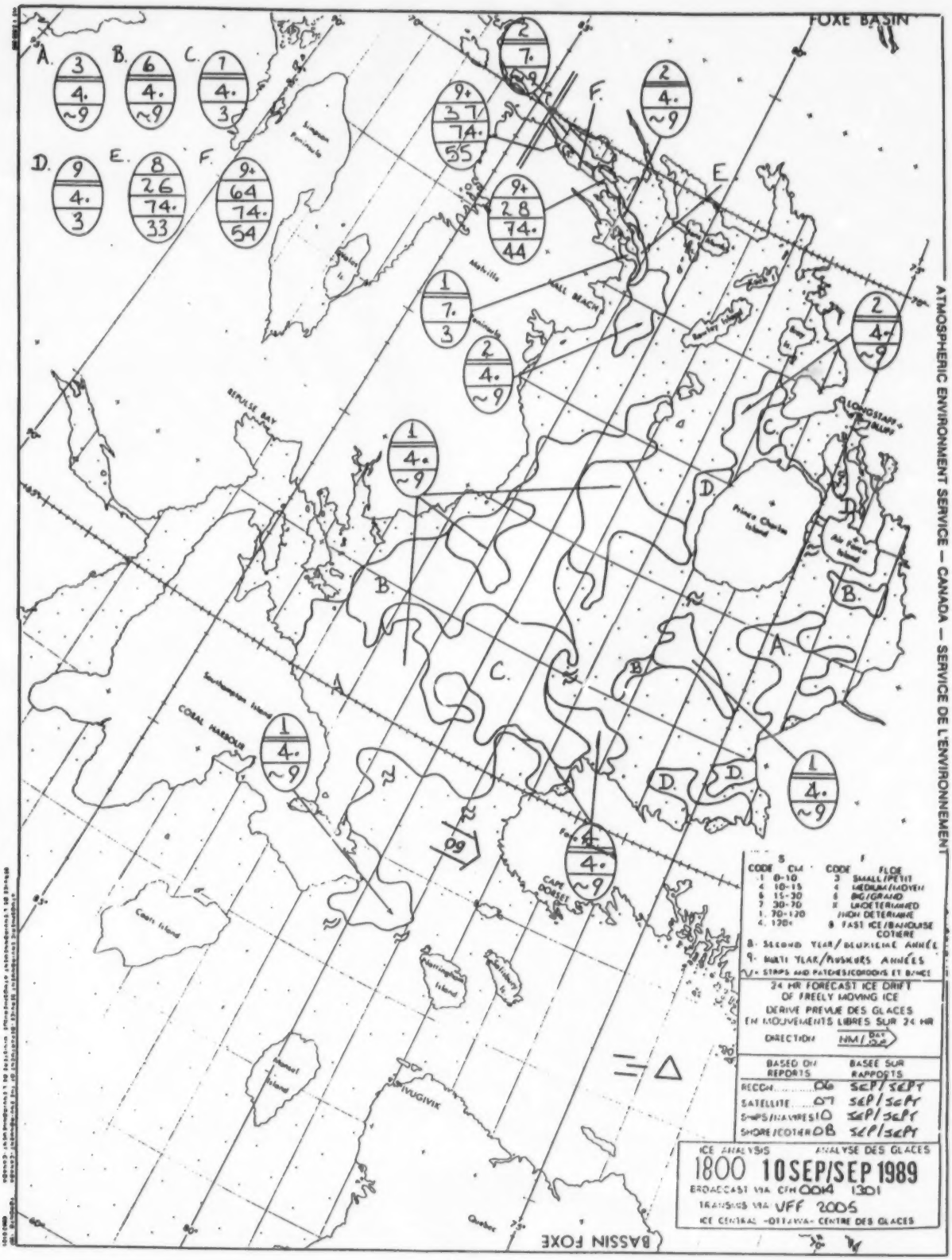

FOXE BASIN
CASPPR ICE REGIME CHART
EXPERIMENTAL BROADCAST TO
M V LUCIEN PACQUIN
FROM NORLAND SCIENCE AND ENGINEERING LIMITED
DATE - 89-09-06
TIME - 1800 UTC
BROADCAST VIA - VFF 2045
VFR 2304
RADIO -
SATELLITE -
SHIPS -
SHORE -
ICE CHART - Note: Ice Considered Decayed
HALL BEACH
REPULSE BAY
Melville Peninsula
Southampton Island
CORAL HARBOUR
Foxe Peninsula
CAPE DORSET
Baffin Island
Coats Island
Mansel Island
DISKO
BASSIN FOXE
LAKE HARBOUR
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE

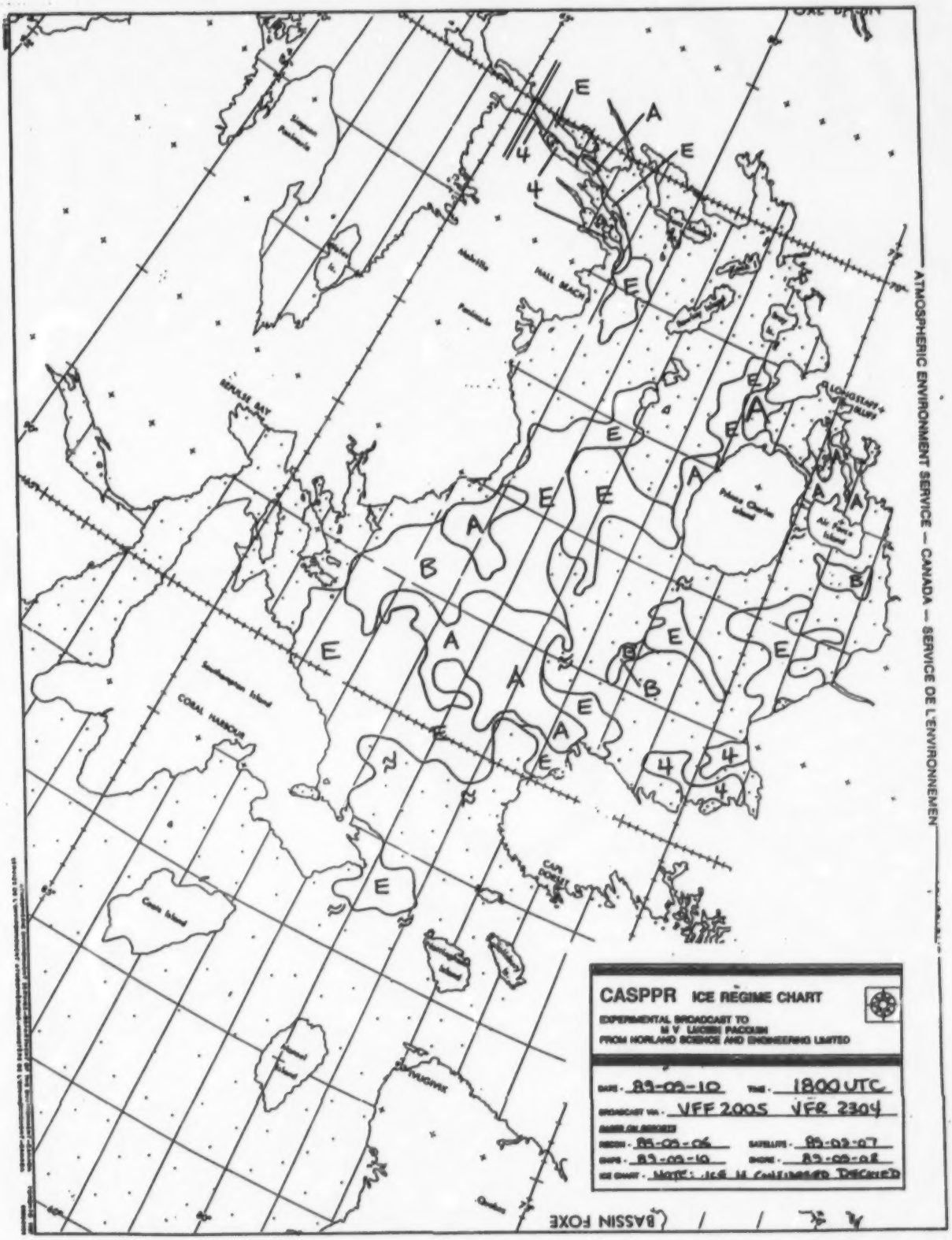

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE
REPULSE BAY
CORAL HARBOUR
Southampton Island
Coats Island
Mansel Island
Nottingham Island
Resolution Island
Baffin Island
Ottawa
CODE CM
0-10
10-15
15-30
30-70
70-120
120+
CODE FLOE
SMALL/PETIT
MEDIUM/MOYEN
BIG/GRAND
X UNDETERMINED
/NON DETERMINÉ
8 FAST ICE/BANQUISE COTIERE
8- SECOND YEAR/DEUXIEME ANNÉE
9- MULTI YEAR/PLUSIEURS ANNÉES
+/- STRIPS AND PATCHES/CORDONS ET BANCS
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASÉE SUR RAPPORTS
RECON..... 06 SEPT
SATELLITE..... 07 SEPT
SHIPS/NAVIRES.. 07 SEPT
SHORE/COTIER.. 04 SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 07 SEP/SEP 1989
BROADCAST VIA: CFH 004, FB01
TRANSMIS VIA: WPP 2005
ICE CENTRAL -OTTAWA- CENTRE DES GLACES

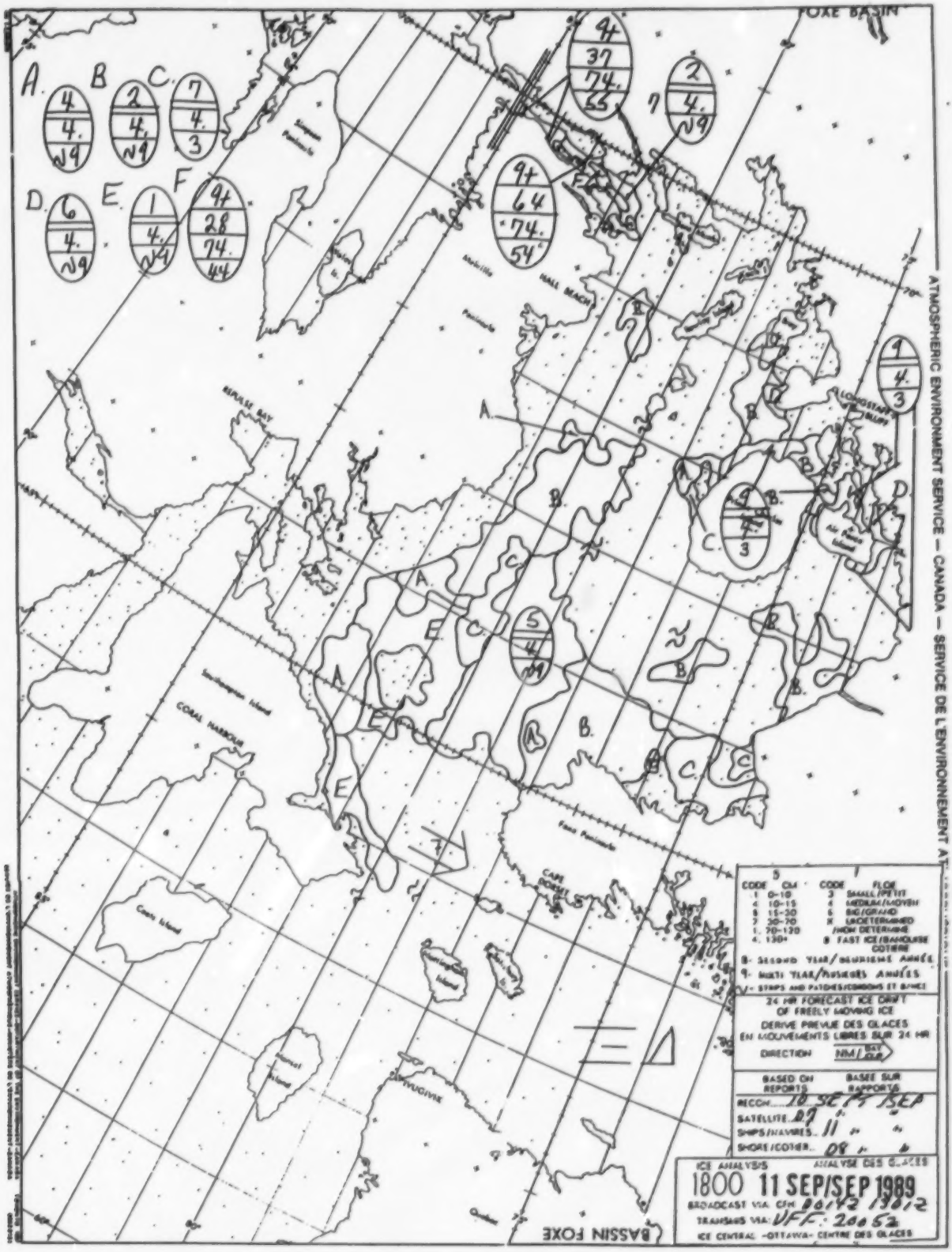

FOXE BASIN
CASPPR ICE REGIME CHART
EXPERIMENTAL BROADCAST TO
M V LUCIEN PACQUIN
FROM NORLAND SCIENCE AND ENGINEERING LIMITED
DATE - 89-09-07
TIME - 1849 GMT
BROADCAST VIA - VFS 2005
VFO 2104
BASED ON OBSERVED
RECON - 89-09-06
SATELLITE - 89-09-02
SHIPS - 89-09-07
SHORE - 89-09-06
ICE CHART - Note : Ice Considered decayed.
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE
BASSIN FOXE

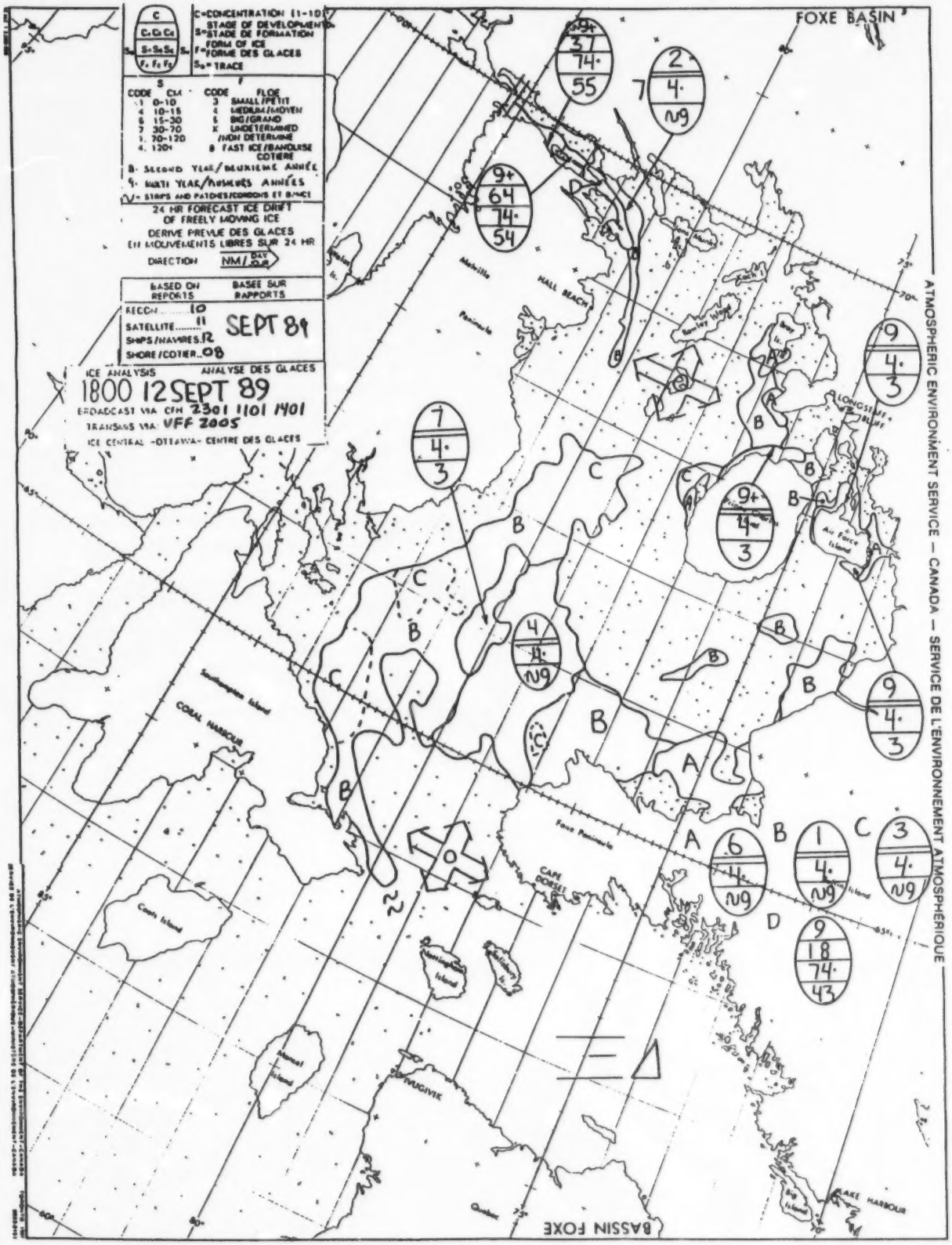

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT A
A
B
C
D
E
F
CODE CM
CODE FLOE
0-10
10-15
15-30
30-70
70-120
120+
FAST ICE/BANQUISE COTIERE
SECOND YEAR/DEUXIEME ANNEE
MULTI YEAR/PLUSIEURS ANNEES
24 HR FORECAST ICE DRIFT
OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES
EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON..... 05 SEPT
SATELLITE..... 07 SEPT
SHIPS/NAVIRES.. 08 SEPT
SHORE/COTIER.. 08 SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 08SEP/SEP 1989
BROADCAST VIA: CFH OTTAWA
TRANSMIS VIA:
ICE CENTRAL -OTTAWA- CENTRE DES GLACES

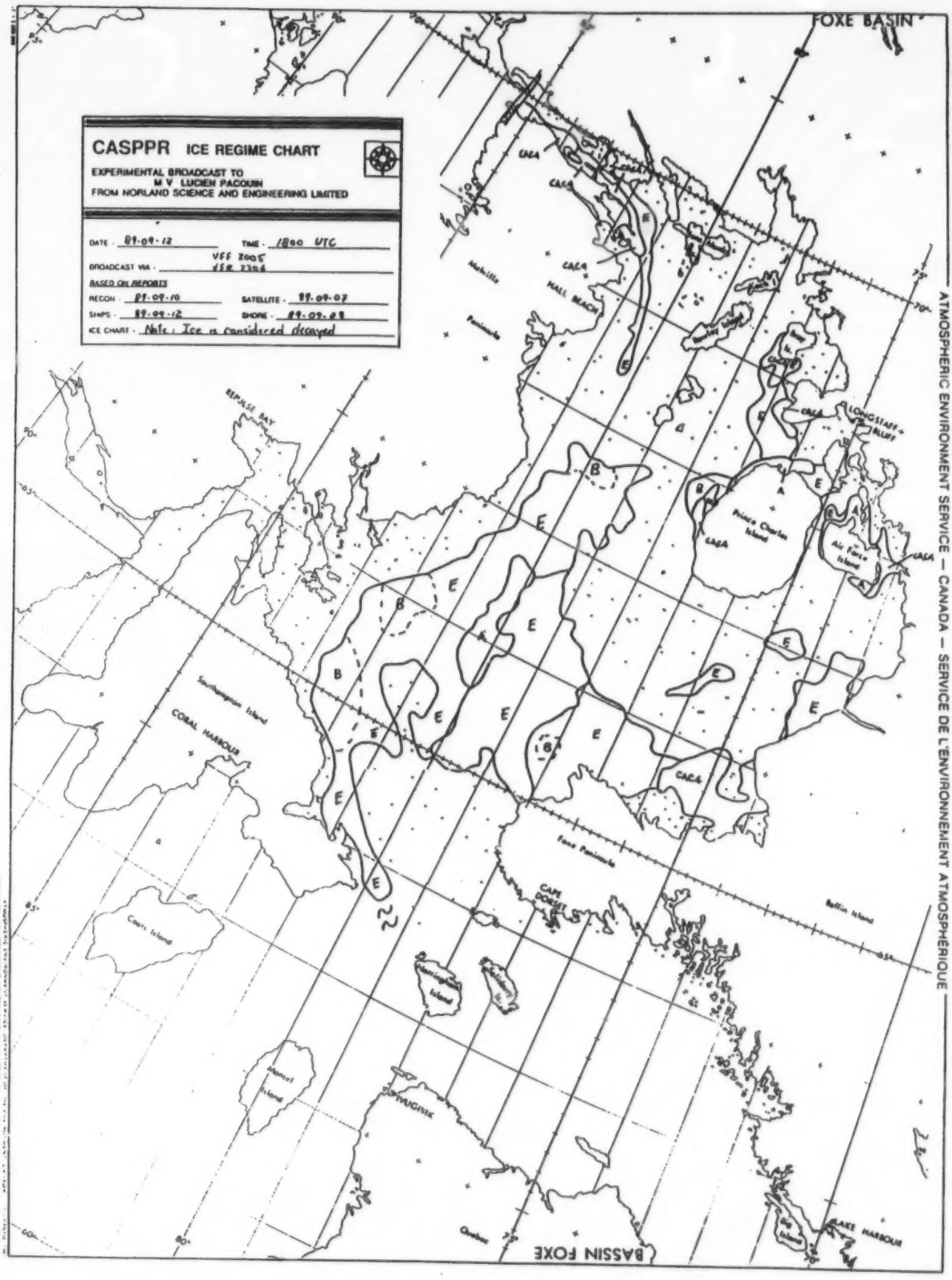

FOXE BASIN
ICE ANALYSIS
ANALYSE DES GLACES
1800 09SEP/SEP 1989
BROADCAST VIA: CFH 6014 13.1
TRANSMIS VIA:
ICE CENTRAL -OTTAWA- CENTRE DES GLACES
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON.....06
SATELLITE.....07
SHIPS/NAVIRES..09
SHORE/COTIER..08
HALL BEACH
LONGSTAFF BLUFF
Prince Charles Island
Air Force Island
Southampton Island
CORAL HARBOUR
Foxe Peninsula
CAPE DORSET
Baffin Island
Coats Island
Mansel Island
Quebec
LAKE HARBOUR
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE

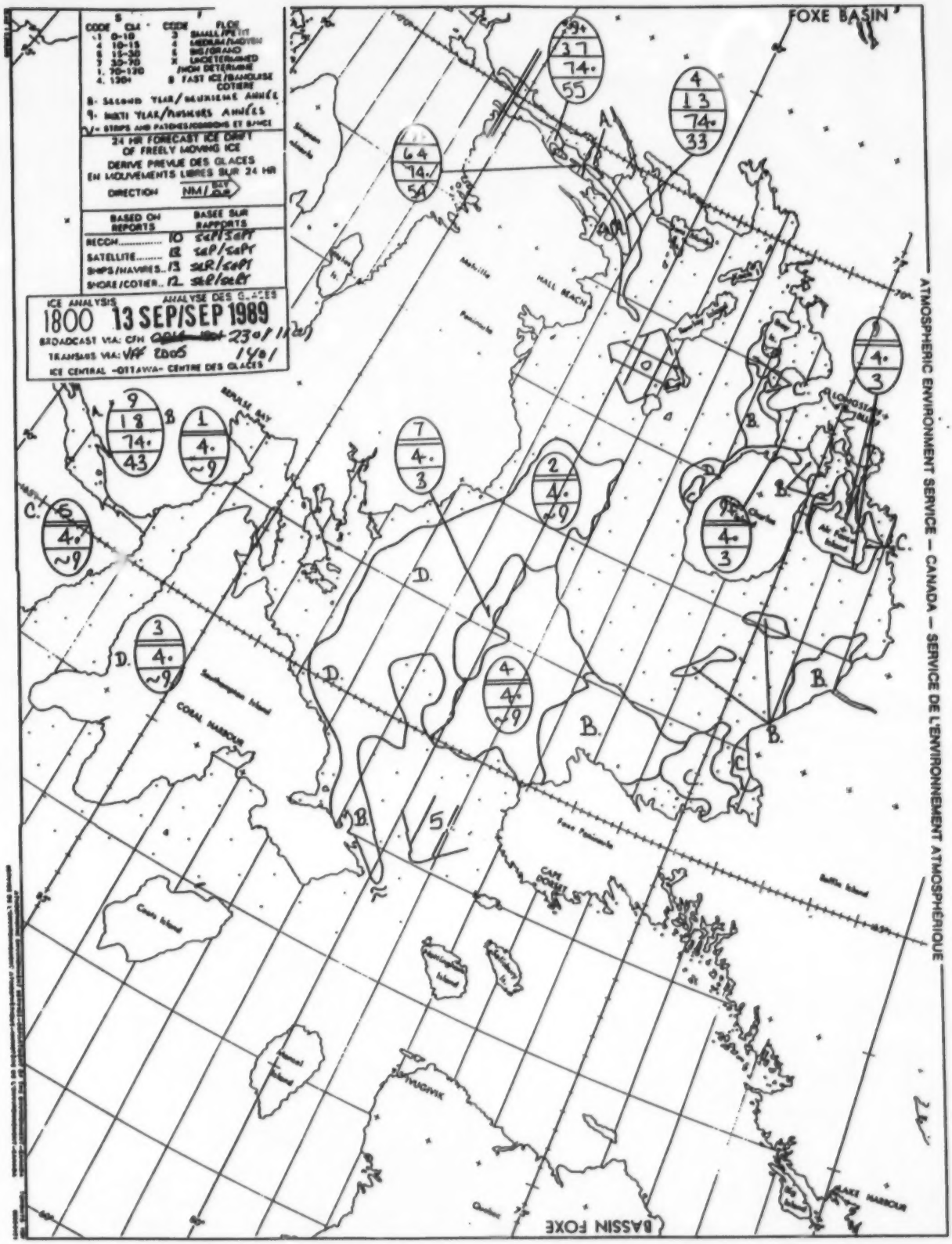

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT
A. 3 4. ~9
B. 6 4. ~9
C. 7 4. 3
D. 9 4. 3
E. 8 26 74. 33
F. 9+ 64 74. 54
9+ 37 74. 55
9+ 28 74. 44
2 7. 9
2 4. ~9
1 7. 3
2 4. ~9
1 4. ~9
2 4. ~9
1 4. ~9
1 4. ~9
4 4. ~9
09
REPULSE BAY
COAL HARBOUR
CAPE DORSET
IQALUIT
CODE CM
1 0-10
4 10-15
6 15-30
7 30-70
8 70-120
9 120+
CODE FLOE
3 SMALL/PETIT
4 MEDIUM/MOYEN
5 BIG/GRAND
X UNDETERMINED/NON DETERMINE
8 FAST ICE/BANQUISE COTIERE
8- SECOND YEAR/DEUXIEME ANNEE
9- MULTI YEAR/PLUSIEURS ANNEES
\/- STRIPS AND PATCHES/CORDONS ET BANCS
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON 06 SEP/SEPT
SATELLITE 07 SEP/SEPT
SHIPS/NAVIRES 10 SEP/SEPT
SHORE/COTIER 08 SEP/SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 10SEP/SEP 1989
BROADCAST VIA CFH 0014 1301
TRANSMIS VIA VFF 2005
ICE CENTRAL -OTTAWA- CENTRE DES GLACES

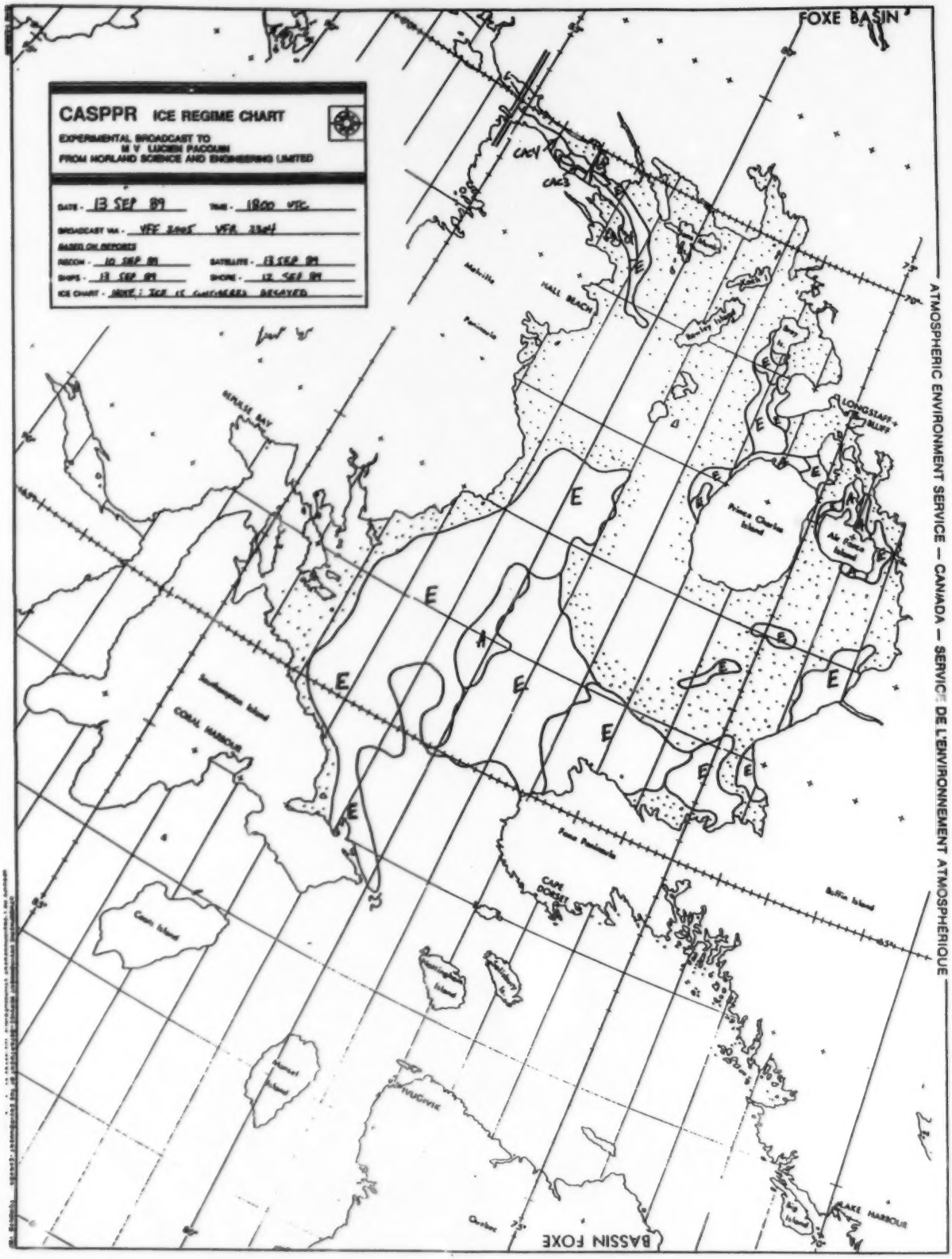

ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMEN
CASPPR ICE REGIME CHART
EXPERIMENTAL BROADCAST TO
M V LAURIER PACQUIN
FROM NORLAND SCIENCE AND ENGINEERING LIMITED
DATE - 89-09-10
TIME - 1800 UTC
BROADCAST VIA - VFF 2005 VFR 2304
BASED ON IMAGES
RADAR - 89-09-06
SATELLITE - 89-09-07
CHARTS - 89-09-10
SHORE - 89-09-08
ICE CHART - NOTE: ICE IS CONCENTRATED TOWARDS
BASSIN FOXE
CORAL HARBOUR
Southampton Island
Coats Island
Mansel Island
Vaughan
Quebec
FULL MACH
REPULSE BAY
LOWTHER ISLAND
Air Force Islands
CAPE DORSET
BAFFIN

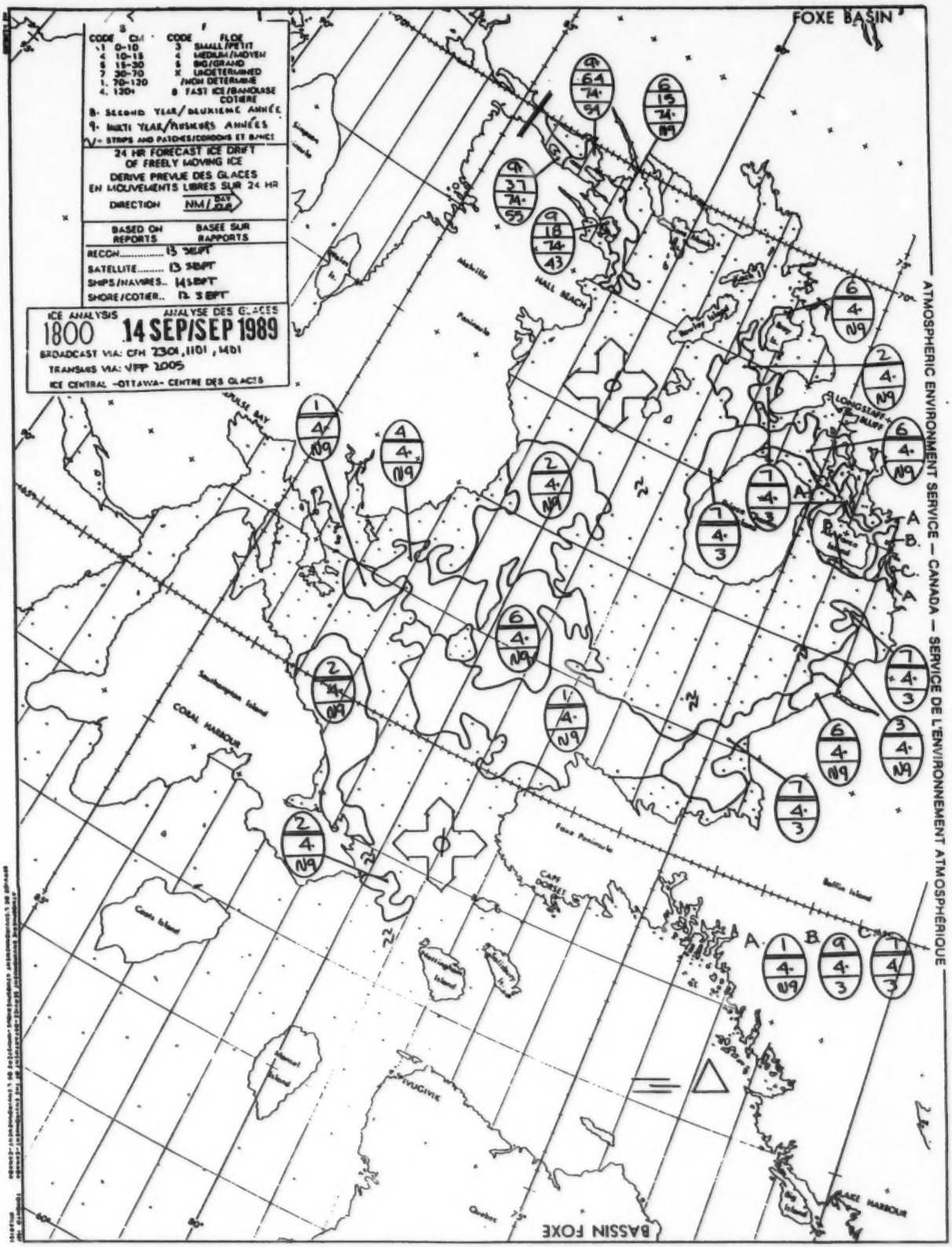

FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT AT
A
B
C
D
E
F
4 4 NJ
2 4 NJ
7 4 3
6 4 NJ
1 4 NJ
9+ 28 74 44
4 37 74 55
2 4 NJ
9+ 64 74 54
9 4 3
9 4 3
5 4 NJ
HALL BEACH
REPULSE BAY
COATS ISLAND
CAPE DORSET
CODE CM
1 0-10
4 10-15
5 15-20
7 20-70
1 70-120
4 130+
CODE FLOE
3 SMALL/PETIT
4 MEDIUM/MOYEN
5 BIG/GRAND
X UNDETERMINED/NON DÉTERMINÉ
8 FAST ICE/BANQUISE CÔTIÈRE
2- SECOND YEAR/DEUXIÈME ANNÉE
9- MULTI YEAR/PLUSIEURS ANNÉES
V- STRIPS AND PATCHES/BANDES ET BANCS
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
NM/MI
KM
BASED ON REPORTS
BASÉE SUR RAPPORTS
RECON. 10 SEP 9 SEP
SATELLITE 07 " "
SHIPS/NAVIRES 11 " "
SHORE/CÔTIER 08 " "
ICE ANALYSIS
ANALYSE DES GLACES
1800 11 SEP/SEP 1989
BROADCAST VIA: CFH 8012 13012
TRANSMIS VIA: VFF 20052
ICE CENTRAL -OTTAWA- CENTRE DES GLACES


FOXE BASIN
C
C=CONCENTRATION (1-10)
STAGE OF DEVELOPMENT
S=STADE DE FORMATION
FORM OF ICE
F=FORME DES GLACES
Sw=TRACE
S
CODE CM
0 0-10
4 10-15
5 15-30
7 30-70
1 70-120
4 120+
F
CODE FLOE
3 SMALL/PETIT
4 MEDIUM/MOYEN
5 BIG/GRAND
X UNDETERMINED/NON DETERMINE
8 FAST ICE/BANQUISE COTIERE
B- SECOND YEAR/DEUXIEME ANNÉE
9- MULTI YEAR/PLUSIEURS ANNÉES
V- STRIPS AND PATCHES/CORDONS ET BANCS
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
NM/MN
KM/KM
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON 10
SATELLITE 11
SHIPS/NAVIRES R
SHORE/COTER 08
SEPT 89
ICE ANALYSIS
ANALYSE DES GLACES
1800 12 SEPT 89
BROADCAST VIA CFH 2301 1101 1401
TRANSAS VIA VFF 2005
ICE CENTRAL -OTTAWA- CENTRE DES GLACES
9+ 37 74 55
2 4 9
9+ 64 74 54
7 4 3
9 4 3
9+ 4 3
4 4 9
9 4 3
6 4 9
1 4 9
3 4 9
9 18 74 43
HALL BEACH
LONGSTAFF BLUFF
Air Force Island
Melville Peninsula
Southampton Island
CORAL HARBOUR
Foxe Peninsula
CAPE DORSET
Coats Island
Mansel Island
Nottingham Island
Resolution Island
DOMINION
LAKE HARBOUR
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE


CASPPR ICE REGIME CHART
EXPERIMENTAL BROADCAST TO
M V LUCIEN PACQUIN
FROM NORLAND SCIENCE AND ENGINEERING LIMITED
DATE - 89-09-12
TIME - 1800 UTC
BROADCAST VIA - VFF 2005
VFR 2384
BASED ON REPORTS
RECON - 89-09-10
SATELLITE - 89-09-07
SHIPS - 89-09-12
SHORE - 89-09-08
ICE CHART - Note: Ice is considered decayed
FOXE BASIN
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE


FOXE BASIN
CODE CM
CODE FLOE
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON
SATELLITE
SHIPS/NAVIRES
SHORE/COTIER
ICE ANALYSIS
ANALYSE DES GLACES
1800 13 SEP/SEP 1989
BROADCAST VIA: CFH
TRANSMIS VIA: VHF
ICE CENTRAL -OTTAWA- CENTRE DES GLACES
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE
BASSIN FOXE


FOXE BASIN
CASPPR ICE REGIME CHART
EXPERIMENTAL BROADCAST TO
M V LUCIEN PACQUIN
FROM HORLAND SCIENCE AND ENGINEERING LIMITED
DATE - 13 SEP 89
TIME - 1800 UTC
BROADCAST VIA - VFF 2005 VFA 2364
BASED ON REPORTS
RECON - 10 SEP 89
SATELLITE - 13 SEP 89
SHIPS - 13 SEP 89
SHORE - 12 SEP 89
ICE CHART - NONE ; ICE ICE CHARTS NOT RECEIVED
REPULSE BAY
HALL BEACH
LONGSTAFF BLUFF
Prince Charles Island
Air Force Island
Southampton Island
CORAL HARBOUR
Coats Island
Foxe Peninsula
CAPE DORSET
Baffin Island
Mansel Island
Nottingham Island
Salisbury Island
Resolution Island
LAKE HARBOUR
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE


FOXE BASIN
CODE CM
CODE FLOE
0-10
10-15
15-30
30-70
70-120
120+
SMALL/PETIT
MEDIUM/MOYEN
BIG/GRAND
VAST/IMMENSE
FAST ICE/BANQUISE COTIERE
SECOND YEAR/DEUXIEME ANNEE
MULTI YEAR/PLUSIEURS ANNEES
STRIPS AND PATCHES/CORDONS ET BANCS
24 HR FORECAST ICE DRIFT OF FREELY MOVING ICE
DERIVE PREVUE DES GLACES EN MOUVEMENTS LIBRES SUR 24 HR
DIRECTION
BASED ON REPORTS
BASEE SUR RAPPORTS
RECON..... 13 SEPT
SATELLITE..... 13 SEPT
SHIPS/NAVIRES.. 14 SEPT
SHORE/COTIER.. 13 SEPT
ICE ANALYSIS
ANALYSE DES GLACES
1800 14 SEP/SEP 1989
BROADCAST VIA: CFH 2301, 1101, 1401
TRANSMIS VIA: VFP 2005
ICE CENTRAL -OTTAWA- CENTRE DES GLACES
Mallik
HALL BEACH
LONGSTAFF BLUFF
Southampton Island
COAL HARBOUR
Coats Island
Foxe Peninsula
CAPE DORSET
Baffin Island
Nottingham Island
Mansel Island
Quebec
PUVIRNITUQ
LAKE HARBOUR
BASSIN FOXE
ATMOSPHERIC ENVIRONMENT SERVICE — CANADA — SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE

APPENDIX D

IDIADS Trafficability Data Reports

APPENDIX D

IDIADS Trafficability Data Reports

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D.1 MV Lucien Paquin Hourly Navigational, Meteorological and Ice Regime Data

D.2 MV Lucien Paquin Hourly Ocean, Ice and Ice Breaking Data

D.3 MV Lucien Paquin Event Data

D.4 IDIADS Reference Log
MV Lucien Paquin, Foxe Basin, September 2-15, 1989

Table D.1

MV Lucien Paquin Hourly Navigational, Meteorological and Ice Regime Data

Date/Voy	Entry			Navigational Data						Meteorological Data								Ice Regime Data			
				POSITION		COURSE	SPEED			TEMPERATURES				WIND		SKY		AES ICE ANALYSIS CHART		OBSERVED ICE CONDITIONS	
	NUM	TYPE	GMT	LAT (N)	LONG (W)			C M G	D M G	DRY (C)	WET (C)	SEA (C)	BAR. PRES	SPD	DIR	COV	RTE	TYPE Dec.Num.	EC	TYPE Dec.Num.	EC
89/09/06 1	5	H	0800	6919	8133	82	9			2.2	1.4		1007	15	330	0		20	E	17	E
89/09/06 1	8	H	0900	6916	8108	107	2	109	9	1.8	1.1		1007	10	335	0		20	E	11	E
89/09/06 1	13	H	1000	6915	8050	96	4	99	6	1.5	0.9		1007	11	345	0		20	E	14	E
89/09/06 1	16	H	1100	6913	8028	80	12	104	8	1.5	0.9		1008	18	320	0		-1	A	20	E
89/09/06 1	17	H	1200	6915	7952	81	13	81	13	3.5	2.7		1007	17	330	0		-1	A	20	E
89/09/06 1	23	H	1300	6916	7917	146	13	85	11	4.1	3.3		1008	9	345	0		20	E	20	E
89/09/08 1	25	H	2100	6906	7907	22	8			3.3	1.9		1006	20	315	0		20	E	20	E
89/09/08 1	26	H	2200	6921	7852	26	13	20	16	2.5	1.4		1006	10	25	9		20	E	20	E
89/09/08 1	30	H	2300	6925	7811	105	17	74	15	1.5	0.8		1007	9	45	5		20	E	20	E
89/09/09 1	35	H	0000	6919	7748	146	2	127	10	0.6	0.1		1007	8	50	5		20	E	14	E
89/09/09 1	39	H	0100	6916	7751	145	2	199	3	0.3	-0.2		1007	9	70	5		20	E	2	B
89/09/09 1	42	H	0200	6914	7743	60	8	125	3	0.8	0.4		1007	12	45	6		20	E	2	B
89/09/13 1	46	H	0100	6903	7755	180	17			-0.5			1001	9	300	9		20	E	17	E
89/09/13 1	49	H	0200	6850	7825	255	17	220	17	-0.6	-0.8		1001	8	255	7		20	E	20	E
89/09/13 1	51	H	0300	6846	7907	245	17	255	15	-0.5	-1.6		1001	9	215	9		20	E	20	E
89/09/13 1	52	H	0400	6842	7937	245	17	227	15	-0.6			1000	10	155	0		20	E	20	E
89/09/13 1	54	H	0500	6833	8013	210	17	257	13	-0.6	-1.3		1000	10	120	6		20	E	20	E
89/09/13 1	56	H	0600	6840	8008	350	8	15	7	-0.9	-1.4		1000	4	140	6		20	E	20	E
89/09/13 1	57	H	0700	6850	8020	345	8	336	11	-0.7	-1.2		1000	5	125	4		20	E	20	E
89/09/13 1	59	H	1100	6809	8036	180	17			1.3	0.3		999	10	140	0		20	E	20	E
89/09/13 1	61	H	1200	6759	8036	125	17	180	10	-0.4			998	11	175	0		20	E	20	E
89/09/13 1	64	H	1300	6741	8021	177	13	163	19	-0.2			999	12	175	0	S	11	E	17	E
89/09/13 1	67	H	1400	6725	8043	205	6	208	18	-0.8	-1.2		999	20	140	X	S	20	E	20	E
89/09/13 1	70	H	1500	6713	8048	170	8	189	12	-1.1	-1.4		998	22	115	X	S	20	E	17	E
89/09/13 1	72	H	1600	6657	8040	175	17	169	16	-0.7	-1.1		998	20	100	X	S	17	E	20	E
89/09/13 1	75	H	1700	6644	8040	210	8	180	13	-0.2	-0.7		998	21	155	X	S	17	E	14	E
89/09/13 1	76	H	1800	6633	8045	127	10	190	11	-0.6	-0.7		998	14	145	X	S	17	E	14	E
89/09/13 1	77	H	1900	6627	8040	162	10	162	6	-0.6	-0.7		999	21	130	0	S	17	E	14	E
89/09/13 1	79	H	2000	6615	8035	160	6	170	12	-0.3	-0.7		1000	14	150	0	S	17	E	11	E
89/09/13 1	82	H	2100	6609	8041	223	4	202	6	-0.2	-0.5		1000	14	150	0		17	E	11	E
89/09/13 1	83	H	2200	6607	8054	185	5	249	6	-0.6	-0.8		1000	12	115	0		17	E	8	E
89/09/13 1	86	H	2300	6557	8047	176	4	164	10	-0.6	-0.7		1000	14	125	X	S	17	E	11	E
89/09/14 1	88	H	0000	6549	8041	180	15	163	8	-0.6	-0.8		1000	17	105	X	S	17	E	14	E
89/09/14 1	89	H	0100	6534	8043	190	11	183	15	-0.7	-0.8		1000	15	110	X	S	17	E	17	E
89/09/14 1	92	H	1000	6525	8053	135	10			-0.2	-0.4		1001	15	75	0		20	E	17	E
89/09/14 1	95	H	1100	6510	8041	170	17	162	16	0.0	-0.2		1001	15	70	X	F	20	E	20	E
89/09/14 1	97	H	1200	6453	8040	180	15	179	17	0.0	-0.3		1001	14	75	0		20	E	17	E
89/09/14 1	99	H	1300	6439	8032	160	17	166	14	0.8	0.2		1001	17	55	0		20	E	20	E
89/09/14 1	101	H	1400	6429	8003	127	17	129	16	1.0	0.4		1000	17	35	0		20	E	20	E
89/09/14 1	102	H	1500	6421	7933	149	17	122	15	1.6	0.9		1000	15	50	0		20	E	20	E
89/09/14 1	103	H	1600	6404	7914	143	17	154	19	2.0	1.2		1000	14	25	0		20	E	20	E
89/09/14 1	105	H	1700	6355	7853	109	17	134	13	1.9	1.2		1000			9		20	E	20	E

Table D.2

MV Lucien Paquin Hourly Ocean, Ice and Ice Breaking Data

Date/Voy	Entry			Ocean			Sea Ice Data										Icebreaking				Iceberg Data							
							ice last hour										last hour				previous hour passes							
							COVER (TENTHS)								FLOE SIZE	FIRST YEAR CHARATERISTICS			% TIME				IN 1/2 nmi				OOU 1/2 nmi			
				WAVES										R															
		T												I								PT		STBD		PT		STBD	
		Y												D	F	D												
		P		H	P E	C A	T		G		F	O		G	Y	I	THCK	STRENGTH	P E	U S	R A	S T O							
	NUM	E	GMT	T	R	P	T	I	G	W	Y	I		G					N	H	M	P	GR	IB	GR	IB	GR	IB	GR	IB
89/09/06 1	5	H	0800	0			1	0	0	0	1	0			3	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/06 1	8	H	0900	0			3	0	0	0	3	0			2	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/06 1	13	H	1000	0			2	0	0	0	2	0			2	4		W	95	5	0	0	0	0	0	0	0	0	0	0
89/09/06 1	16	H	1100	0			TR	0	0	0	TR	0			1				99	0	0	0	0	0	0	0	0	0	0	0
89/09/06 1	17	H	1200	0			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/06 1	23	H	1300	0			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/08 1	25	H	2100	1			IF	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/08 1	26	H	2200	0			IF	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/08 1	30	H	2300	0			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/09 1	35	H	0000	0			2	0	0	0	2	0			1				95	5	0	0	0	0	0	0	0	0	0	0
89/09/09 1	39	H	0100	0			6	0	0	0	6	0			2	4		W	90	10	0	0	0	0	0	0	0	0	0	0
89/09/09 1	42	H	0200	0			6	0	0	0	6	0			1				35	60	5	0	0	0	0	0	0	0	0	0
89/09/13 1	46	H	0100	0			1	0	0	0	1	0			2	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	49	H	0200	0			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	51	H	0300	0			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	52	H	0400	0			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	54	H	0500	0			TR	0	0	0	TR	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	56	H	0600	0			TR	0	0	0	TR	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	57	H	0700	0			TR	0	0	0	TR	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	59	H	1100	0			IF	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	61	H	1200	0			TR	0	0	0	TR	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	64	H	1300	0			1	0	0	0	1	0			1				99	1	0	0	0	0	0	0	0	0	0	0
89/09/13 1	67	H	1400	0			TR	0	0	0	TR	0			1				99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	70	H	1500	0			1	0	0	0	1	0			2	4		W	99	1	0	0	0	0	0	0	0	0	0	0
89/09/13 1	72	H	1600	0			TR	0	0	0	TR	0			1				99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	75	H	1700	0			2	0	0	0	2	0			2	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	76	H	1800	0			2	0	0	0	2	0			2	4		W	99	1	0	0	0	0	0	0	0	0	0	0
89/09/13 1	77	H	1900	0			2	0	0	0	2	0			2	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/13 1	79	H	2000	0			3	TR	0	0	3	0			3	4		W	99	1	0	0	0	0	0	0	0	0	0	0
89/09/13 1	82	H	2100	0			4	1	0	0	3	0			3	4		W	98	2	0	0	0	0	0	0	0	0	0	0
89/09/13 1	83	H	2200	0			5	1	0	0	4	0			3	4		W	95	5	0	0	0	0	0	0	0	0	0	0
89/09/13 1	86	H	2300	0			3	TR	0	0	3	0			2	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	88	H	0000	0			2	0	0	0	2	0			2	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	89	H	0100	0			1	0	0	0	1	0			2	4		W	99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	92	H	1000	0			1	0	0	0	1	0			2	4		W	50	0	0	50	0	0	0	0	0	0	0	0
89/09/14 1	95	H	1100	0			TR	0	0	0	TR	0			1				99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	97	H	1200	0			1	0	0	0	1	0			1				99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	99	H	1300	1			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	101	H	1400	0			OW	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	102	H	1500	0			IF	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	103	H	1600	0			IF	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0
89/09/14 1	105	H	1700	0			IF	0	0	0	0	0							99	0	0	0	0	0	0	0	0	0	0	0

Table D.3

MV Lucien Paquin Event Data

Date/Voy	Entry			Identification			Detection				Result							Photo			Nav. Aids				
	NUM	TYPE	GMT	PORT	AHD	STBD	CSE	SP	BRG	RANGE	PASS	CCAUSE	LTAYSE	TEVER	MULTIPLE			FILM	FRAME ST	FRAME FN	R1	R2	LTS	VIS	REF
89/09/02 1	1	E	0208																		6	SBY	ON	5	Y
89/09/05 1	2	E	2038		////S																6	SBY	ON	5	Y
89/09/05 1	3	E	2334															1	6		6	SBY	ON	5	Y
89/09/06 1	4	E	0705																		6	SBY	ON	7	Y
89/09/06 1	6	E	0824	FS5//	FS5//	FS5//															6	SBY	ON	7	
89/09/06 1	7	E	0831				115	4													6	SBY	ON	7	
89/09/06 1	9	E	0905					2													6	SBY	ON	5	
89/09/06 1	10	E	0911					3										1	7		6	SBY	ON	5	
89/09/06 1	11	E	0942					2										1	8		6	SBY	OFF	4	Y
89/09/06 1	12	E	0946																		6	SBY	OFF	4	
89/09/06 1	14	E	1013				112	8													12	SBY	OFF	4	
89/09/06 1	15	E	1044		////A		85	10													12	SBY	OFF	4	
89/09/06 1	18	E	1209		////A		85	13													24	SBY	OFF	4	
89/09/06 1	19	E	1244		////A		140	13													24	SBY	OFF	4	
89/09/06 1	20	E	1249		////A		86	13													24	SBY	OFF	4	Y
89/09/06 1	21	E	1252		////A		140	13													24	SBY	OFF	4	
89/09/06 1	22	E	1255		////A		146	13													24	SBY	OFF	4	
89/09/08 1	24	E	2053				22	5													3	SBY	OFF	4	Y
89/09/08 1	27	E	2207		////A		77	17													6	SBY	OFF	4	
89/09/08 1	28	E	2244		////A		105	17													6	SBY	OFF	4	
89/09/08 1	29	E	2245		E////					6.00											6	SBY	OFF	4	Y
89/09/08 1	31	E	2308	E////	E///A	E////	141			1.50											12	SBY	OFF	4	
89/09/08 1	32	E	2333				141	4										1	12		12	SBY	OFF	4	
89/09/08 1	33	E	2342				146	2										1	13	14	12	SBY	OFF	4	
89/09/08 1	34	E	2348					2													12	SBY	OFF	4	Y
89/09/09 1	36	E	0018	EC9//	EC9//	EC9//	196	2										1	15	16	12	SBY	OFF	4	
89/09/09 1	37	E	0030	EC9//	EC9//	EC2//	240	2										1	17	19	12	SBY	OFF	4	Y
89/09/09 1	38	E	0048	EC9//	EC7//	EC9//	172	2										1	20		12	SBY	OFF	4	
89/09/09 1	40	E	0132															1	21	22	12	SBY	ON	7	
89/09/09 1	41	E	0154		FW9B/		90	8							D	M	4				12	SBY	ON	7	
89/09/09 1	43	E	0201	W////	W////	W////		2																	Y
89/09/09 1	43	E	2200	FC5//	FC5//	FC5//																			Y
89/09/10 1	43	E	0144		FC1//		250	2																	Y
89/09/10 1	43	E	0158																						Y
89/09/10 1	43	E	0201					0																	
89/09/10 1	43	E	2021	FC5//	FC5//	FC5//												1	23	25				1	Y
89/09/10 1	43	E	2316	FC9//	FC9//	FC9//		1										1	26					1	Y
89/09/10 1	43	E	2342	W////	W////	W////		0																	Y
89/09/11 1	43	E	2306	W////	W////	W////																			Y
89/09/13 1	44	E	0004		E////		213	5		4.00											12	SBY	OFF	4	Y
89/09/13 1	44	E	0045	FC9//			195	15			0.25							1	27		12	SBY	OFF	4	
89/09/13 1	45	E	0057		////A		180	17													12	SBY	OFF	4	
89/09/13 1	47	E	0110		////A		230	17													24	SBY	OFF	5	

Table D.3

MV Lucien Paquin Event Data

Date/Voy	Entry			Identification			Detection				Result						Photo			Nav. Aids				
															MULTIPLE									
		TYP									CAUSE	CALYPSE	TYPE	FAIL			FRAME						VIS	REF
	NUM	E	GMT	PORT	AHD	STBD	CSE	SP	BRG	RANGE	PASS	E	S	E	R	E	M	ST	FN	R1	R2	LTS	S	F
89/09/13	1	48	E	0156		////A		255	17											24	SBY	OFF	5	
89/09/13	1	50	E	0254		////A		245	17											24	SBY	OFF	6	
89/09/13	1	53	E	0436		E////		234	17		3.00									12	SBY	ON	7	
89/09/13	1	53	E	0455		E////	E////	210	17											12	SBY	ON	7	Y
89/09/13	1	55	E	0517	E////	E////	E////	25	17											12	SBY	OFF	7	Y
89/09/13	1	55	E	0542				120	8											12	SBY	ON	7	
89/09/13	1	58	E	0714	E////	W////	E////	310	8											12	SBY	ON	7	Y
89/09/13	1	58	E	0718	E////	W////	E////	190	8											12	SBY	ON	7	
89/09/13	1	58	E	0725	W////	W////	W////		15											12	SBY	ON	7	
89/09/13	1	60	E	1145		E////		130	17		9.00									48	SBY	OFF	4	
89/09/13	1	60	E	1156		E////	E////	123	17											48	SBY	OFF	4	
89/09/13	1	60	E	1204			FC9//	133	17			0.25								12	SBY	OFF	4	
89/09/13	1	62	E	1206		E////	E////	122	17		3.00									12	SBY	OFF	4	
89/09/13	1	62	E	1216		E////	E////	160	17											12	SBY	OFF	4	Y
89/09/13	1	62	E	1219		FP2//		168	10		0.25									12	SBY	OFF	4	
89/09/13	1	62	E	1224		FP2//		156	6								1	28		12	SBY	OFF	4	Y
89/09/13	1	62	E	1232				158	4											12	SBY	OFF	4	
89/09/13	1	62	E	1243				155	10											12	SBY	OFF	4	
89/09/13	1	62	E	1313	FCS//	FCT//	FCS//	220	17											6	SBY	OFF	2	
89/09/13	1	63	E	1254				170	13											12	SBY	OFF	3	
89/09/13	1	65	E	1309					15								1	29		12	SBY	OFF	2	
89/09/13	1	66	E	1357	E////	E////		210	8		1.50									6	SBY	OFF	2	
89/09/13	1	68	E	1405		E///A		190	6		1.00									6	SBY	OFF	2	
89/09/13	1	68	E	1415				180	4											6	SBY	OFF	2	
89/09/13	1	68	E	1419		W////		180	10											6	SBY	OFF	2	
89/09/13	1	69	E	1448				170	6											6	SBY	OFF	2	
89/09/13	1	69	E	1459		W////		180	8											6	SBY	OFF	2	
89/09/13	1	71	E	1517		E////		160	14		3.00									6	SBY	OFF	2	
89/09/13	1	71	E	1525			FCS//	170	17			0.10								6	SBY	OFF	2	
89/09/13	1	73	E	1601	E////	FC2//	E////	175	10		0.30									6	SBY	OFF	2	
89/09/13	1	73	E	1629	FC3//	FC4//	FC5//		5		0.25									6	SBY	OFF	2	Y
89/09/13	1	74	E	1648	FC1//	FC1/A	FC1//	210	10											6	SBY	OFF	2	
89/09/13	1	78	E	1917	FC6//	FC3//	FC3//		6								1	30	31	6	SBY	OFF	3	Y
89/09/13	1	78	E	1927													1	32		6	SBY	OFF	3	
89/09/13	1	80	E	2040																6	SBY	OFF	4	
89/09/13	1	81	E	2043	F/5//	F/5//	F/5//	180	3								1	33		6	SBY	OFF	4	
89/09/13	1	84	E	2209	F/3//	F/3//	F/5//	150	10											6	SBY	OFF	3	
89/09/13	1	85	E	2250		F/4//			5											6	SBY	OFF	3	
89/09/13	1	87	E	2337	E////	FC1//	E////	165	10											12	SBY	OFF	3	
89/09/14	1	90	E	0102		FS///					0.30	0.00		D	M					6	SBY	OFF	7	
89/09/14	1	91	E	0140		FS3//			0											6	SBY	ON	7	Y
89/09/14	1	91	E	0930	E////	W////	E////	130	5											12	SBY	OFF	5	Y
89/09/14	1	93	E	1028		////A		170	17											12	SBY	OFF	3	

Table D.3

MV Lucien Paquin Event Data

Date/Voy	Entry			Identification			Detection				Result					Photo		Nav. Aids				
	NUM	TYPE	GMT	PORT	AHD	STBD	CSE	SP	BRG	RANGE	PASS	CAUSE	LAYSE	TERSE	MULTIVLE	FILM	FRAME ST	FN	R1	R2	LTS	VIS	REF
89/09/14 1	94	E	1040																12	SBY	OFF	2	
89/09/14 1	96	E	1109		E////		122	8		1.50									12	SBY	OFF	2	
89/09/14 1	96	E	1117		FC3//					0.50									12	SBY	OFF	2	
89/09/14 1	96	E	1125		W////		170	12											12	SBY	OFF	2	
89/09/14 1	98	E	1237		////A		160	17											12	SBY	OFF	4	
89/09/14 1	100	E	1302		////A		129	17											48	SBY	OFF	4	
89/09/14 1	104	E	1619		////A		109	17											48	SBY	OFF	4	
89/09/14 1	106	E	1705	W////	W////	W////													48	SBY	OFF	4	Y

Table D.4

IDIADS Reference Log
MV Lucien Paquin, Foxe Basin, September 2-15, 1989

Event No.	Details
1	Boarded MV Lucien Paquin general cargo vessel.

Call Sign:	VCLW
Tonnage:	10,034 gross
	7,005 net
Draft:	9.5m
Engines:	2 x 4400 BHP
Owner:	Logistec Corporation, Montreal, Quebec
Charter-Party:	Transport Desgagnes Ltd., Montreal, Quebec
Registration:	Trois Rivieres, Quebec

Engines started in preparation for departure from Hall Beach, N.W.T. for voyage to Igloolik, N.W.T.

2 First CASPPR Experimental Ice Chart received.

3 Engines started in preparation for departure from Igloolik, N.W.T. for voyage to Rowley Island, N.W.T.

CCGS Norman Macleod Rogers standing by at Igloolik for tanker escort operations; MV Lucien Paquin will sail alone.

Departure delayed until 0700 hrs in order that a band of close pack first year ice, depicted on the AES Ice Analysis Chart, can be negotiated in daylight.

4 Depart Igloolik.

5 Passing ice edge running parallel to ships path, ~500m to starboard.

8 Although patches of 7-9/10 are observed, predominant matrix in ice regime is 5/10 on average, presenting favourable conditions for slow, manoeuvring passage.

11 Passage being made on manual steering, with approximate path to follow indicated by master; helmsman chooses course. Direct helm orders given only rarely, when direct contact with ice is unavoidable.

20 Course change at event #19 was in error (premature). Corrected.

23 Approaching ice free harbour at Rowley Island.

24 Depart Rowley Island bound for Bray Island, N.W.T.

29 Ice edge ahead at about 5 n.mi., concentration unknown; reaches across horizon to ~30° off both port and starboard. Planned course change at event #28 does not bring course clear of ice.

34 Visual and radar observations indicate between 2/10 and 5/10 first year brash ice in all directions except to rear.

37 Following edge of pack ice, observe there are many small and medium floes within the matrix. The visual differences between sail heights and melt ponds/thaw holes is so pronounced that the floes closely resemble a close pack of brash and rubble pieces. Virtually all ice in this region originated in rubble fields, very rough with sail heights up to 2m. Surfaces are significantly weathered and sprinkled with dust and dirt.

39 Edge of pack ice to east, and open water beyond, is apparent from marine radar. Vessel continues on south-easterly heading to avoid higher concentrations of pack -- perhaps up to 9/10, although difficult to confirm from this distance.

43 <u>89/09/09</u>

0201 Slowing on approach to anchorage 1 n.mi. away, which in turn is 5 n.mi. off coast of Bray Island (due to bathymetry limitations).

1200 Throughout day ice edge to west has moved gradually closer to vessel, stretching at least 3 n.mi. to north and south, probably much more.

2200 Ice reaches ship and barge/cargo operations halted. Between 4 and 6/10 first year brash and ice cake is drifting at 1-2 knots under 15 knot north-westerly winds.

<u>89/09/10</u>

0144 Engines started and ship moves through drift ice into 1/10 concentration.

0158 At anchor with only a trace of ice between ship and shore, however barge reports a strip of ice is packed along the coast of Bray Island, about 1 n.mi. deep. Barge must negotiate this ice, and it slows down cargo operations.

Winds presently 23 knots from north-west; assume currents and/or tides are keeping ice away from shore.

2021 Photographs are a port to starboard panorama of ice conditions typical of last 24 hours -- 4 to 6/10 in strips and patches of 9/10 first year small floe and ice cake. Ice has gradually covered anchorage waters, and barges are hoisted aboard.

It is noteworthy, given the prevailing 20 knot westerly winds, that until now little ice has appeared to the east, between ship and shore. Ice drift is in south-east direction, influenced by strong tidal activity in the area.

2316 Pack ice regime is moving by and the compact (9/10) ice edge before the westerly winds is now 0.25 n.mi. to west, with open water beyond. Engines started and vessel moves ahead at dead slow speed towards open water.

2342 Anchor in open water.

89/09/11

2306 Clear and cloud free all day, with morning winds 17 knot northerlies. Open water conditions continue, although 1.5 n.mi. wide strip of 7/10 first year persists along the coast, slowing cargo operations though not stopping them.

44 Engines started and ship departs Bray Island, bound for Cape Dorset, N.W.T. Ice edge visible at 4 n.mi. to port, forcing deviation from base course of 199°. Limits of ice patch are clearly delineated on marine radar, and course is altered to avoid the encounter.

53 Being squeezed between pack ice on starboard (west) side and sparse, problematic bathymetry to port; continue to skirt ice edge in open water. From the marine radar, the ice appears to be a meandering strip about 1 n.mi. wide, however difficult to confirm due to sea clutter and darkness.

55 Captain called onto bridge when it becomes apparent there is no open water route which can be safely followed. Course is reversed to head back northward. About 3 n.mi. to the north the strip appears lighter on radar, however a closer inspection will be necessary.

58 Course altered to west to cross strip at point where it tapers to only a trace of first year. For the last hour the strip has been only ~0.5 n.mi. wide, yet no attempt was made to pass through.

62 1216 Although ice edge can be avoided by keeping a south-easterly course, AES Analysis Chart indicates lighter conditions to south-west. For this reason vessel prepares to cross strip of 9/10 at a narrow point where open water is visible on other side.

1224 Beginning to see ice edge beyond the open water ahead, and course is altered to swing back towards the south-east through the lighter ice immediately ahead of the vessel.

73 1629 Course alterations of 5-10° becoming common as wheelsman manoeuvres vessel through a broad strip of loose pack ice. Only very small pieces are touched -- no notable impacts have occurred since departing Bray island.

76 Photos: 1/30 is view south-west to starboard of 3/10 first-year ice.
1/31 is view south-west to port of 6/10 first-year ice.
1/32 as 1/31 above, at closer range.

82 As in northern Foxe Basin observe that small and medium floes (see photo 1/34) all show very rough topography. Ice edge ahead appears heavier than that encountered over last 24 hours.

83 These light impacts occurred only when immediate concentrations exceeded 4/10 first year ice cake and small floe, and were virtually unavoidable.

91 0140 Continue to encounter occasional strips and patches of 3/10 first year in an area depicted as open water on the AES Analysis Chart. The ice has posed no threat, as pieces stand out well on radar in calm water, however it does slow progress when visibility reduced by darkness and blowing snow, as at present.

Shut down engines and drift freely until morning light.

0930 Start engines and resume voyage; open water ahead.

106 In open water following planned approach to Cape Dorset anchorage.